Power Generation and POWER PLANT ENGINEERING

For ALL Power Engineers • Steam, Electricity and All Other Power Engineering Services

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MARCH
1950

They build 'em

This photograph of an Elliott 975,000-lb-per-hr vertical deaerating heater mounted on a horizontal storage tank, was made on the assembly floor with the unit under final water test of 200 psi, and before the various gages and control valves were installed.

ELLIOTT DEAERATING

big at Elliott

Utility companies have long been coming to Elliott Company for the biggest deaerating heaters required by their fine new stations. They know that Elliott engineers have unparalleled experience in building and applying deaerating heaters to get the most effective and efficient feedwater heating and deaerating results. ***An example is the unit illustrated.***

The Elliott units going to plants both big and small now have the "new look." They no longer are encumbered with external vent condensers. Elliott has "built in" the vent condenser, making a more compact unit and one easier to maintain—two big advantages. In addition, in the new units, all interior parts exposed to possible corrosion are of stainless steel. Performance is as it always has been with Elliott units—par excellence.

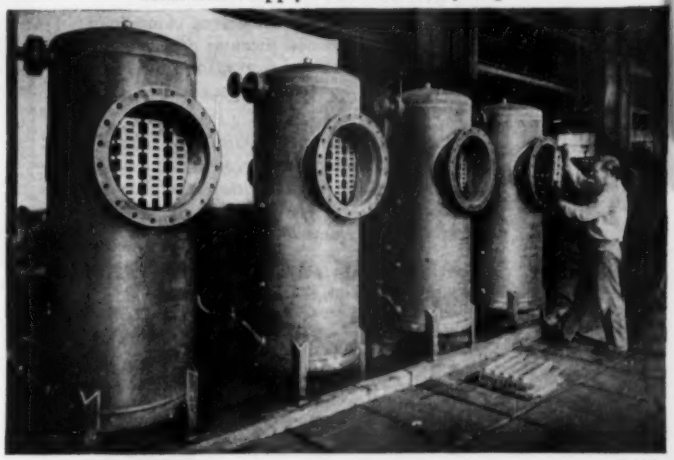
Descriptive bulletin on request.

ELLIOTT COMPANY **Deaerator & Heater Dept.**
JEANNETTE, PA.

PLANTS AT: JEANNETTE, PA. • RIDGWAY, PA.
AMPERE, N. J. • SPRINGFIELD, O. • NEWARK, N. J.
DISTRICT OFFICES IN PRINCIPAL CITIES

This photograph shows the deaerating heater from the opposite side. At top is the relief valve opening; at bottom, the steam equalizing connection with the storage tank, and the three openings in a line are the main steam supply and the auxiliary drip returns.

..and small too



These four deaerating heaters of the new design, with built-in vent condensers, are being assembled ready for test. These units will serve as high pressure evaporator preheaters.

N-997

FEEDWATER HEATERS

have no tubular vent condensers

THE Armstrong hardened chrome steel valve opens wide and closes tight — with a snap! This eliminates throttling and consequent wire drawing. The Armstrong free-floating lever mechanism is almost frictionless. The bucket and valve lever assembly are 18-8 corrosion resistant stainless steel. The mechanisms of Armstrong steam traps for low and medium pressures are identical in materials and workmanship to those used in Armstrong traps for pressures to 1500 psi, 900 F.

There is nothing in an Armstrong trap to bind, stick, collapse or leak. *Now is the time to quit working for your steam traps and buy the traps that will work for you.* Call your nearby Armstrong representative today.

ARMSTRONG MACHINE WORKS
810 Maple St., Three Rivers, Mich.

50% SAVINGS IN MAINTENANCE since installing Armstrong steam traps on the heating system at *John Deere Ottumwa Works, Ottumwa, Iowa.* This is typical of reports from Armstrong users.

THE 36-PAGE ARMSTRONG STEAM TRAP BOOK contains complete data on the design, operation, selection and installation of Armstrong steam traps for all services. Send for your free copy.

ARMSTRONG STEAM TRAPS

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Published Monthly by

TECHNICAL PUBLISHING CO.
53 W. JACKSON BLVD.
CHICAGO 4, ILL.

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Subscription Information—Published Monthly. Prices: United States and Possessions one year $10.00, Canada one year $11.00. Other countries one year $12.00. Single copies $1.00. Changes of address should give both old and new address and reach us by 15th of month to be effective with following month's issue. The Annual Index is furnished as a part of the December issue.

Contents of back issues of Power Plant Engineering and Power Generation will be found in both the Industrial Arts Index and the Engineering Index on file in Public Libraries.

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ABC

Power Generation

March 1950

VOLUME 54—NUMBER 3

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Notes on This Issue

Mercury Power Plant Special 12-Page Section

Because the mercury cycle is ideally suited for small plants requiring extremely high efficiency and because of the great importance of the whole development, this special section covers in four parts complete information on the history and present status of the mercury power cycle.

As you know, experimental work on the mercury-vapor-steam binary cycle goes back to 1921 and the first commercial unit was installed at South Meadow Station of Hartford Electric Co. in 1927. That unit operated for 20 years with high efficiency and little trouble.

Other experimental units were built; one by General Electric Co. in Schenectady and the Kearney plant of Public Service Electric & Gas Co. of N. J., but the war stopped all further development.

After the war work was resumed. A new 15,000 kw mercury turbine replaced the old unit at South Meadow and has operated for a year. The new Schiller Station of Public Service Co. of N. H. went into operation in January, and is not only the first complete mercury-steam power station but also the most efficient station of its size in the world.

Another mercury power installation is at the Pittsfield Works of General Electric Co.

In the special section you will find diagrams, data and pictures on all six of the mercury power installations to date; a clear explanation of the mercury cycle; a description of the new Schiller Station and of the new South Meadow unit.

This material gives our readers a complete and up-to-date understanding of this highly important power development and the section should be kept as a permanent reference.

Ignition Baffles Improve Single-Retort Stoker Performance

The single-retort underfeed stoker leads all others in number of units in use. It fires thousands of small industrial boilers with coal, in capacities from 20 to about 200 hp. It is most generally used in situations where oil and gas fuels are most competitive. For that reason, any development that will reduce its labor cost or increase its efficiency is important.

This article describes such a development, now being thoroughly tested on a 178-hp boiler in a heating plant at Pennsylvania State College. Tests show that already the development, which is a water-cooled baffle placed over the stoker fuel bed in the furnace, has increased the output of the boiler by 40 to 50 per cent, increased the CO_2, reduced smoke, fly ash, operating labor. The firemen, at first doubtful, are now sold on the idea.

One big feature: It can be applied to new or existing installations.

New Turbine Room for B. F. Nelson Mfg. Company

A little over a year ago we published a description of the new boiler room of the B. F. Nelson Mfg. Co. in Minneapolis as a fine example of industrial boiler plant design.

Now, we present a description of the new turbine room constructed during the year and placed in operation last summer. It is a beautifully designed turbine room and with a 3000-kw turbine generator for normal load and a 750-kw unit for standby service, it satisfies all the power requirements.

Centralized Control for Steam-Electric Power Stations

For years control engineers have been developing centralized controls for power plant equipment but interest has greatly increased because of costs of skilled operators, outdoor equipment and larger turbine generator and boiler units.

Control centralization leads to control panels sometimes 24 to 30 ft. long, hundreds of gages, adjustors, controllers, alarms, and signal lights.

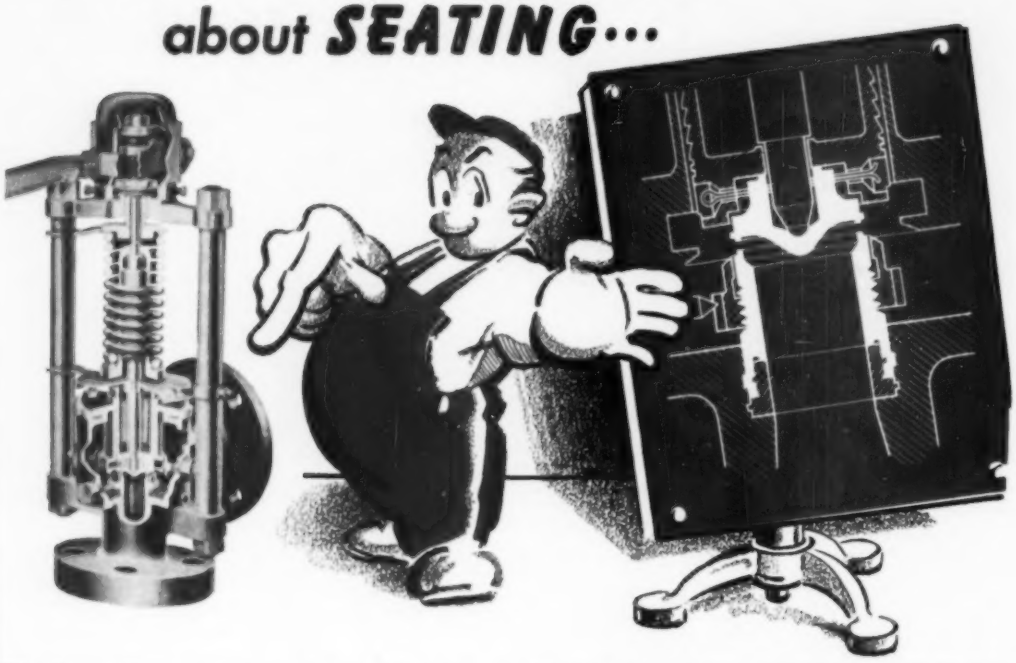
Mr. Mallory presents the arrangements in four recent installations. The control room at Sewaren uses many new ideas. It is now possible for operators in both central stations and industrial plants to use many new ideas and pieces of equipment.

The whole objective is to reduce operating costs.

Another article by Mr. B. F. Borgel of Pennsylvania Electric Co. will be published in the near future giving further details and suggestions.

We Studied SAFETY VALVE LEAKAGE

— Here's what we found out about SEATING...



We found – what most power plant men already know...that in order to be tight, a safety valve must have matched, wear resistant, corrosion resistant seating surfaces, and that the disc must seat square.

We found – what power plant men have long suspected...that uneven expansion, causing dragging of one seating surface over the other, can destroy the seat so completely that the safety valve has to be overhauled or replaced, even though it has never been popped.

We found ...that when nozzle and disc are made of alloys with the same coefficient of expansion, and with sections designed so that their rate of heat absorption is the same, destructive drag is eliminated. This is one of the basic features of the Gentzel Design, and is the reason Foster 38-SV Safety Valves can be guaranteed to stay tight.

To you ...this means elimination of costly boiler outage due to safety valve leakage. Other guaranteed *and* proven advantages are...consistently accurate popping ...minimum blow-down, which can be held to as little as 1%...highest relief capacity for a given nominal valve size...and extremely low maintenance.

One Executive of a large Eastern Utility put it this way, "Leakage is a serious item. Every time we have to shut down for leaky safety valves, we tie up several million dollars worth of equipment. It costs us thousands of dollars a day."... The Superintendent of a mid-west generating station said, "My Foster 38-SV's are the only safety valves I have that don't leak."

Foster 38-SV Gentzel Design Safety Valves are made for pressures as low as 35 pounds as well as for pressures in excess of 2500 pounds. For details on the design and construction features that enable this valve to outperform ANY other safety valve... and for a list of installations near you, get in touch with your Foster Representative or with us direct.

FOSTER ENGINEERING Company

PRESSURE REGULATORS...RELIEF AND BACK PRESSURE VALVES...AUTOMATIC STOP AND CHECK VALVES...ALTITUDE VALVES...DAMPER REGULATORS...FAN ENGINE REGULATORS... PUMP GOVERNORS...TEMPERATURE REGULATORS...LIQUID LEVEL CONTROLLERS...FLOAT AND LEVER BALANCED VALVES...NON-RETURN AND TRIPLE DUTY VALVES...VACUUM REGULATORS OR BREAKERS...SIGHT FLOW BOXES...STRAINERS...SAFETY VALVES...SIRENS

835 LEHIGH AVENUE • UNION, N. J.

ENGINEERS' PREVIEW

IMPROVEMENTS in certain types of gaskets, packings, valve diaphragms and similar products may be made by means of special polyvinyl alcohol (PVA) compositions. An example of such a composition is as given by C. A. Porter in U. S. Patent 2,464,717:

To polyvinyl alcohol (completely saponified) 100 parts, are added to glycerine 20 parts, diacetin 3 parts and water, 10 parts; these are used as plasticizers for the composition, while formamide 5 parts and furfural 5 parts serve as reactants for the PVA. The mixture is formed into sheets in a platen press at temperatures of at least 300 F. The resulting molded material, it is claimed, has unusual toughness and, while quite hard, also has some flexibility. It has very high tensile strength, high abrasion resistance, excellent fatigue characteristics, dimensional stability and good water resistance for PVA composition, and no exudation whatever. In addition, it displays the advantages of PVA with regard to resistance to hydrocarbon fuels and oils and organic solvents.

★ ★ ★

REMEMBER THE MEMEX, suggested by Dr. Vannevar Bush near the close of the war, and reported at the time in this department (then entitled *Front Lines)?* Dr. Bush had the idea of a device for analyzing a great mass of technical data available in published form in order to trace ideas through it by association, in the same way that the human brain does it when looking up data on a given subject. Dr. Bush made this suggestion on the basis of various developments in microfilm technique, electronic computing devices and selecting methods, rapid exposure and printing of film, and many other new ideas, which were being used for military purposes and naturally could not be discussed in detail.

Now, however, by utilizing ideas of this kind, a fundamental advance in the organization, storage and dissemination of knowledge may be foreseen in an electronic brain machine developed jointly by the U. S. Department of Commerce and the U. S. Department of Agriculture. Known as the Rapid Selector, the machine stores vast amounts of scientific information in its system, automatically pores over it, selects what is sought after by its operator and then hands him copies of what he wants.

The selector makes use of standard 35-mm motion picture film, on each reel of which can be stored the contents of almost 500,000 conventional library cards. When the information is microfilmed, a predetermined code pattern, consisting of black and white squares, is simultaneously printed on the film, indicating the subject to which the information relates.

The operator of the machine, wishing to obtain everything the selector possesses on a particular subject, places a master key card in the mechanism. The selector's electric eyes then scan the film at a rate of more than 60,000 subjects a minute, automatically select the desired frames and copy them on a separate film by use of high-speed photoflash techniques. It is estimated that it would take the rapid selector only about 15 minutes to review all the entries that have appeared in the last 30 years in *Chemical Abstracts*, a standard guide to all chemical research.

A report describing the Rapid Selector in detail, with illustrations, Report PB 97535, $2.50 a copy, is available from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

IN CASE you think counting the grains of sand at the seashore is impossible, science recently unveiled an instrument that counts invisible particles in the air a million billion times smaller than a grain of sand. The instrument doesn't even "pick 'em up and lay 'em down." It just looks at them, blinks an "eye" when they occur in the air being sampled by the instrument, and records the occurrence on paper.

The device was developed by Dr. Bernard Vonnegut, weather scientist in the General Electric Co.'s Research Laboratory at Schenectady, N. Y. and was described by him in a paper before the National Air Pollution Symposium in Pasadena, Calif.

The work was done under Project Cirrus, joint weather research program of the U. S. Army Signal Corps, and the Office of Naval Research, in consultation with the G-E Research Laboratory. The device will be used by Dr. Vonnegut and other G-E weather scientists to study the behavior or particles in the atmosphere, determine how they disperse, find out how far they travel, and so on.

Such knowledge will be useful in developing atmosphere-seeding techniques for a material called silver iodide, which in similar small particle form causes supercooled or below-freezing moisture to turn to snow. The device also should prove useful in air pollution studies to trace the development and dissipation of various smokes from industrial centers, and populated areas.

★ ★ ★

CORROSION FATIGUE CRACKING in Steam Pipe Systems at Power Stations is the title of a 20-page, illustrated booklet recently received from the British Electricity Authority. It is the report of a Corrosion Fatigue Committee appointed in 1947. It covers the mechanism of crack development, locations where failure may be expected, detection and observation, layout of the new plant, alterations to existing plant, operation of steam pipe systems and plant supervision.

The study of this subject in Great Britain was undertaken because, in recent years, a number of serious cases of cracking occurred in the steam pipe systems of British power stations.

★ ★ ★

FOURTH WORLD POWER CONFERENCE, according to present plans, will be held in London during the week of July 10 to 15, 1950. This is the first plenary meeting of the Conference since that held in Washington in 1936 and its theme will be "World Energy Resources and the Production of Power."

H. C. Forbes, 4 Irving Place, New York 3, N. Y., is secretary-treasurer of the Executive Committee of the U. S. National Committee and can supply full information about the Conference.

Papers will not be read at the technical sessions, although they will be printed and distributed to those in attendance in advance of the Conference. The technical sessions will be given over to the presentation of summaries by General Reporters whose further duty will be to promote discussion. Papers in full, general reports and summaries of discussions will be reproduced in the Transactions. The two working languages of the Conference are English and French.

Topics to be covered are: Division I—Energy Resources and Power Developments; Division II—Preparation of Fuels; Division III—Production of Power.

FIRST FULLY AUTOMATIC "self-starter" for a gas turbine in central station service has been completed by the Switchgear Division, General Electric Co. The equipment, which performs the starting and stopping operations automatically and in sequence, will be put in service by Central Maine Power Co. at the Farmingdale Station.

A 3500-kw gas turbine, fueled by bunker C oil installed at that station, will be put through its normal starting and stopping sequence by the equipment. The following functions will be automatically performed by the unit in properly-timed sequence in starting:

1. Energizes the turning gear to "break away" the unit.
2. Starts the cranking motor to bring the unit up to partial speed and actuate the air compressor.
3. Opens the fuel valve.
4. Ignites the fuel.
5. Allows the unit to accelerate under its own power.
6. Transfers the fuel supply from starting diesel fuel to bunker C for running.

After reaching normal speed, the unit is controlled by the operator in the same manner as a steam turbine to synchronize the generator with the bus.

The stopping functions are automatically performed in the following sequence:

1. Fuel supply transferred back to diesel fuel to purge the fuel lines of bunker C oil.
2. Fuel supply is gradually reduced till the flame goes out.
3. Unit coasts to a standstill.

While provision is made for annual testing of the individual steps, the starting and stopping sequence is always automatic.

Protective features are included to provide emergency shut down in case of abnormal temperatures, fuel and air pressure.

★ ★ ★

$F = M_1 \times M_2 \times M_3$. That formula promises to be one of the most practical time savers power engineers have had for speeding up the determination of the proper pipe size to handle a given steam flow at a given pressure and temperature with a prescribed allowable pressure drop. All those M's are multipliers and you get them from three tables published on two facing pages in the July 1949 issue of *Power Generation*. These multipliers are tabulated for pressures from 29 in. Hg vacuum to 3000 psig, corresponding saturation temperatures and total steam temperatures, for pressure drop from 0 to 10 psi per 100 ft of pipe, for size of pipe from $\frac{1}{4}$ in. to 30 in. and for Schedules 10, 40, 80 and 160. The whole thing is all on two pages, in the handiest possible form for use on the engineer's desk or for putting in his notebook or file.

The method was worked out by A. B. Stickney, former chief engineer for Armour and Company, former president of the ASRE and now with The Rust Engineering Co. Mr. Stickney first used the method in working out pipe sizes in refrigeration, and it was published in the *Refrigerating Data Book*. His own men found it so useful and practical that he then worked out these similar tables for steam and water flows. The method is based on the well-known Moody procedure, given in complete detail several years ago in the *Transactions of the ASME*.

Now the tables, with full instructions for their use, as originally published in this magazine, have been reprinted by Rust in a handy folder. If you missed the tables in the July issue or did not clip them for your file then, write the Engineers' Preview Editor for a copy of the reprint.

ONE OF the most important of recent engineering papers was that on Invention and Sifting Out Engineering Facts, by E. G. Bailey, delivered last year as the James Clayton Lecture before The Institution of Mechanical Engineers in London, England. Much has been said and written by various authors on the subject of invention but never have we seen the process itself discussed so effectively as Mr. Bailey has done it in this paper.

The reason for this is obviously that Mr. Bailey is here preaching what he has himself practiced so often, as in developing the various inventions that led to his founding of the Bailey Meter Co. and later to the vice-presidency of The Babcock & Wilcox Co.

He begins his paper by explaining what an invention is and the difference between invention and research. He makes the point that since basic inventions are now waning, research should be conducted so that more valuable invention will be forthcoming.

Then after he has explained the various reasons why inventions need to be made, he discusses what to us seems the most important phase of the subject: the actual mental and physical processes of the practice of invention. He explains in detail the specific procedure of invention, how it is reduced to practice and the relations of instinct to invention. He includes illustrations from his own experience showing how simple is the process of inventing when there is an incentive. He concludes with the idea that sifting out of facts from theories and propaganda leaves only the best and most useful things. Why, he asks, cannot facts in the area of human relations be dealt with in a similar manner?

★ ★ ★

ORGANIZED EFFORTS to reduce production costs will result in an unusually large volume of plant modernization and rehabilitation in many segments of industry in 1950, Otto F. Sieder, executive vice president and general manager of the H. K. Ferguson Co. said in the firm's annual forecast based on a survey of Ferguson representatives in major industrial communities across the country.

Construction volume in the industrial field seems certain to decline—possibly as much as 15 per cent. On the other hand, engineering volume will hold firm, and may even increase over 1949 figures. Two reasons:

1. Modernization and rehabilitation programs usually require greater engineering expenditures per dollar of construction than new plants; and
2. Comparatively few plants were on the drawing boards in 1949. More are expected to be planned and engineered in 1950. These will not go into actual construction this year, however, since engineering is generally a year or more ahead of building.

Many modernization programs will take a spectacular turn because it is sometimes more economical to construct an entirely new plant than to rehabilitate an existing facility to the desired degree of efficiency.

Several factors were said to be working in favor of lower costs: competition and abundance of supply; increasing productivity from labor; deliveries for most items are again predictable and enable builders to schedule their operations more effectively; the backlog of wartime industrial buildings for sale by the War Assets Administration is practically depleted. Many large corporations are building modern distribution facilities on a nationwide basis. One reason for decentralization is that freight rates have risen to the point where they are now a major item of cost.

EFFECTIVE LUBRICATION REDUCES 2 VITAL EXPENSES

Use Texaco Ursa Oils and save on fuel consumption and upkeep costs

When you lubricate your Diesels with Texaco Ursa Oils you can be sure of —

- **free rings**
- **better compression and combustion**
- **freedom from harmful carbon, sludge, varnish**
- **longer life for bearings and all moving parts**

You get these benefits because *Texaco Ursa Oils* are especially made for Diesel lubrication, have exceptional resistance to oxidation, exceptional ability to stand up under high temperature and pressure. Dollar-wise, they assure you the trouble-free, full power performance that means savings in fuel consumption and reduction in maintenance costs.

There is a complete line of *Texaco Ursa Oils.* They are approved by leading Diesel manufacturers and — *more stationary Diesel h.p. in the U. S. is lubricated with Texaco Ursa Oils than with any other brand!*

Step up your Diesel efficiency and step down your costs. A Texaco Lubrication Engineer will gladly help you. Just call the nearest of the more than 2,000 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Ursa Oils

FOR ALL DIESEL ENGINES

TUNE IN . . . TEXACO presents MILTON BERLE on television every Tuesday night. METROPOLITAN OPERA radio broadcasts every Saturday afternoon.

Boiler Water Indication

AT THE BOILER DRUM
YARWAY FLOATLESS HI-LO ALARM WATER COLUMN with VERTICAL PRESSURE-SEALED FLAT GLASS GAGES. Glass gages have patented "floating assembly" that reduces glass breakage and leakage. See Bulletin WG-1811.
YARWAY
H
L
PHILADELPHIA, PA.
PATENT APPLIED FOR

YARWAY

ON THE LEVEL with a Yarway System

It's accurate! It's where you can see it!

These two most important needs for boiler water level indication are assured with a Yarway system.

Yarway indicating equipment is accurate because it is *operated directly by the boiler water itself*. Yarway Weight-operated Hi-Lo Alarm Water Columns with either Secure Inclined or Flat Glass Vertical Gages take care of the job at the boiler drum. On the instrument panel or other desired location, Yarway Remote Liquid Level Indicators bring overhead gage readings down to convenient, easy eye-level vision. By use of a Control Unit on the indicator, additional Hi-Lo light or sound alarms can be located at any place in the plant.

The Yarway HI-LO-GRAPH, a panel-mounted *recording* indicator, gives a 24-hour record of boiler water levels.

Yarway engineers will gladly show you how the Yarway Boiler Water Indicating System increases power plant *safety* and *efficiency*.

For the full story on Yarway Indicators, write for a free copy of Yarway Bulletin WG-1822.

YARNALL-WARING COMPANY, 114 Mermaid Avenue, Philadelphia 18, Pa.

BRANCH OFFICES IN PRINCIPAL CITIES

ON THE INSTRUMENT PANEL

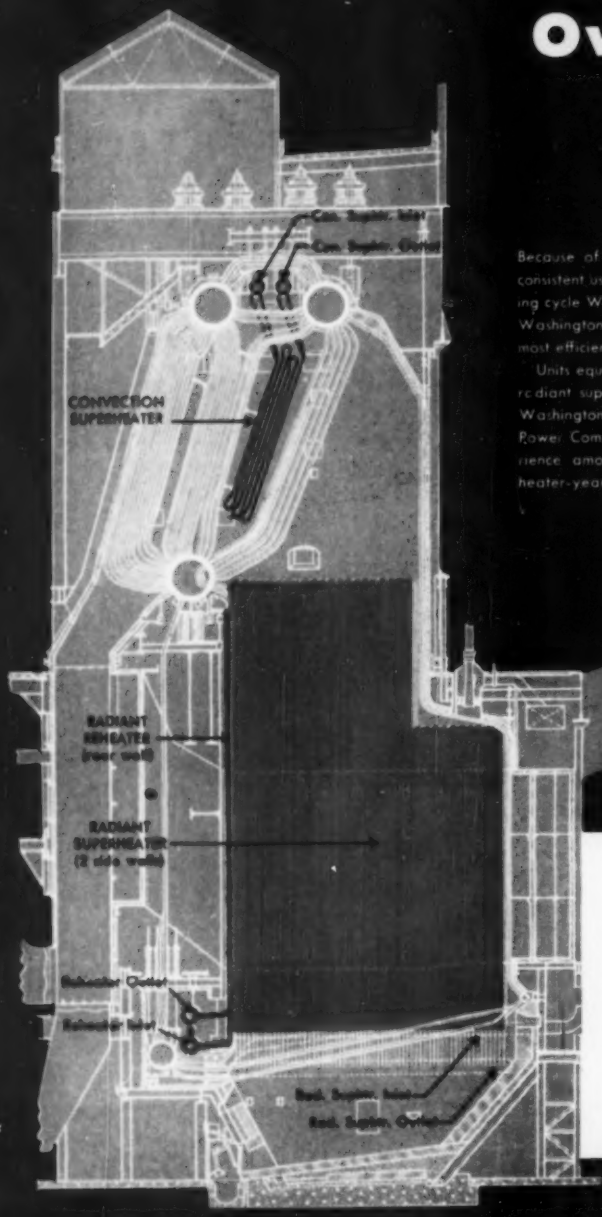
YARWAY REMOTE LIQUID LEVEL INDICATOR, operated directly by the boiler water itself, by the pressure differential between a constant head and the varying head in the boiler drum. Indicating mechanism is never under pressure—no stuffing boxes. See Bulletin WG-1822.

YARWAY HI-LO-GRAPH RECORDER provides not only instant indication but also 24-hour recording of boiler water levels. See Bulletin WG-1830.

ANYWHERE IN THE PLANT

YARWAY REMOTE HI-LO ALARM SIGNALS, lights or horns. Operated by Control Unit attached to Remote Liquid Level Indicator or Recorder. Any number can be installed, at any desired locations throughout the plant. See Bulletin WG-1822.

Over 500

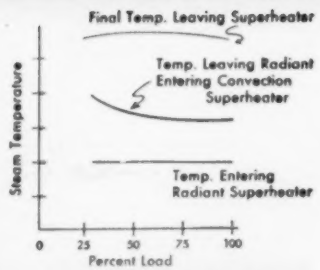


Because of a farsighted program involving the consistent use of a high temperature resuperheating cycle Wisconsin Electric Power Company's Port Washington Station is today one of the country's most efficient power plants.

Units equipped with FW radiant reheaters and radiant superheaters at both Lakeside and Port Washington Stations of the Wisconsin Electric Power Company show a total of successful experience amounting to over 500 "radiant superheater-years."

1949

FOSTER



COMBINATION SUPERHEATER

Fig. 1
Note flat final steam temperature

FOSTER WHEELER CORPORATION

"superheater-years" in one utility alone*

*See TRANSACTIONS of the ASME, August, 1949, page 738

1948 1943 1935 1924

WHEELER RADIANT REHEATERS and SUPERHEATERS

Foster Wheeler experience in the design and operation of radiant and convection surface dates from 1902 with the introduction of commercial use of superheated steam into the United States. ***A wider selection of fuels*** for resuperheating units may be obtained by using superheaters and reheaters which include FW radiant heat absorbing sections. This is in sharp contrast to the all convection type which will provide a wide range of steam temperature control at the risk of considerable slagging in both furnace and hotter convection zones. This also applies in the case of non-reheat units with wide control ranges. Performance data on units equipped with FW radiant surfaces for superheating and resuperheating at the Lakeside and Port Washington Stations of the Wisconsin Electric Power Company also testify to such advantages as ***a very high operating reliability*** and ***the compensating effect in temperature characteristics*** as against exclusively convection arrangements with steep load temperature curves (see figures 1 and 2). The fact that 35.6% of the total BTU duty on Unit No. 5 at Port Washington will be performed by the superheater and reheater well illustrates the magnitude of this function of a modern steam generator.

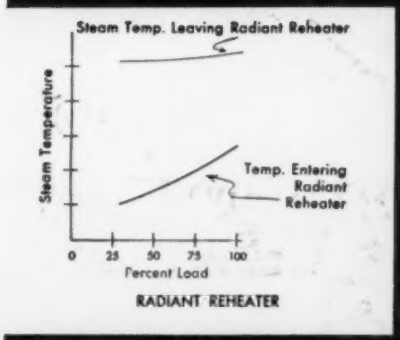


Fig 2
characteristics over wide load ranges

Availability To date, four units incorporating FW radiant reheating and radiant and convection superheaters have been installed in the Port Washington Station. The fourth unit was started in August 1949 and a fifth is in fabrication. The combined availability of the first three operating units, the initial one of which was installed in 1936, is 95% for a total of 147,235 hours of service as of December 26th, 1948.

For further information, write for Paper No. 48-A-120

165 BROADWAY, NEW YORK 6, N. Y.

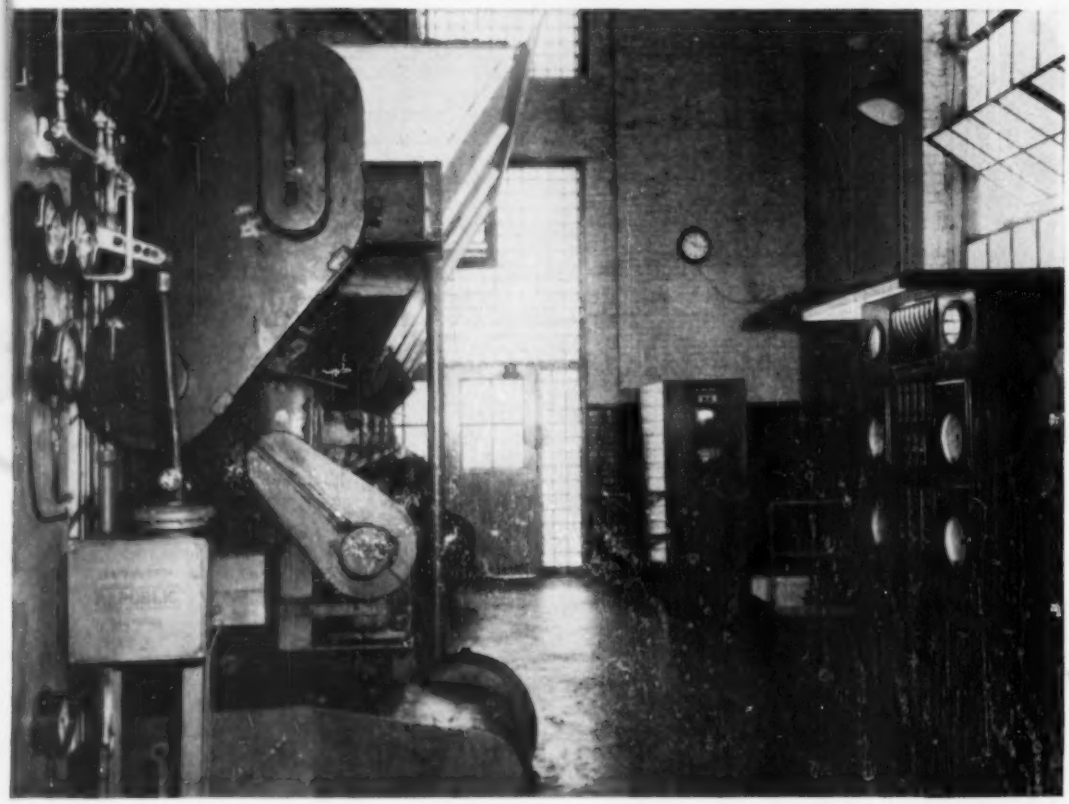
● the Municipal

Electric Light and Power Plant

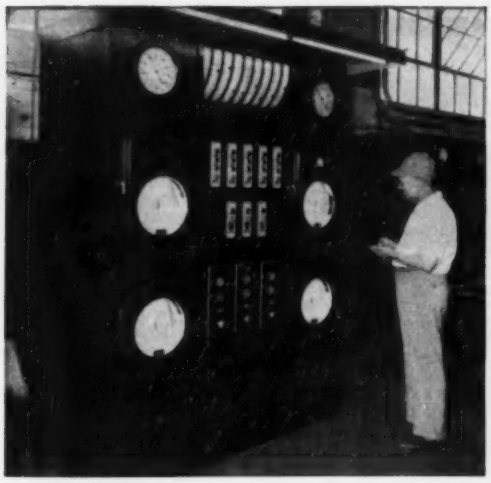
at Hannibal, Missouri

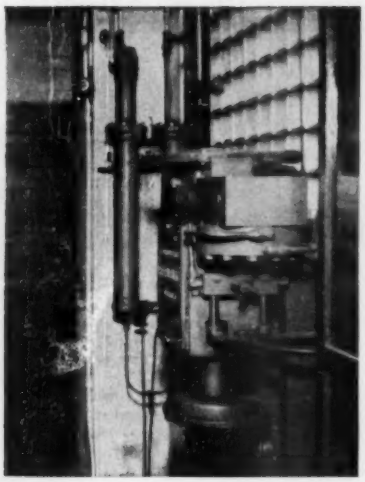
[the home of Mark Twain and his famous characters, Tom Sawyer and Huckelberry Finn]

HAS THE ANSWER TO



View of boiler room showing stokers and Republic boiler instrument and control panel.





Left: All essential boiler records and manual controls are centralized on the Republic boiler panel.

Right: Republic regulator controlling, in measured amounts, the air flow to the boiler.

LOWER STEAM COSTS

A REPUBLIC automatic combustion control system that operates their boiler at test standards, 24 hours a day, is the answer.

Installed at the Hannibal municipal plant is a modern three drum, 90,000 lb. per hour, 400 psi boiler with forced and induced draft fans and fired by a traveling grate spreader type stoker.

The REPUBLIC control system enables them to take full advantage of those economies which have been "built in" their boiler and its auxiliaries. It automatically increases and decreases simultaneously the fuel and air supply to the boiler in the correct amount to maintain constant steam pressure and in the correct ratio to maintain maximum combustion efficiency at all ratings.

The REPUBLIC combustion control system makes and co-ordinates these adjustments automatically, at the same time permits the operator to assume manual control from a centralized control point on the instrument panel whenever advisable.

REPUBLIC combustion control systems are designed and built for all sizes of boilers — all types of fuel firing — all load conditions and any arrangement of draft equipment. We will be glad to supply full information on REPUBLIC Control Systems — just write for Data Book No. S-21.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

Pair of Aces —BACK TO BACK!

ALLIS-CHALMERS BOILER FEED PUMP

The barrel pump, below, is one of three types we build for boiler feed service. The various features of this pump have been exhaustively tested and proved satisfactory for highest pressure requirements.

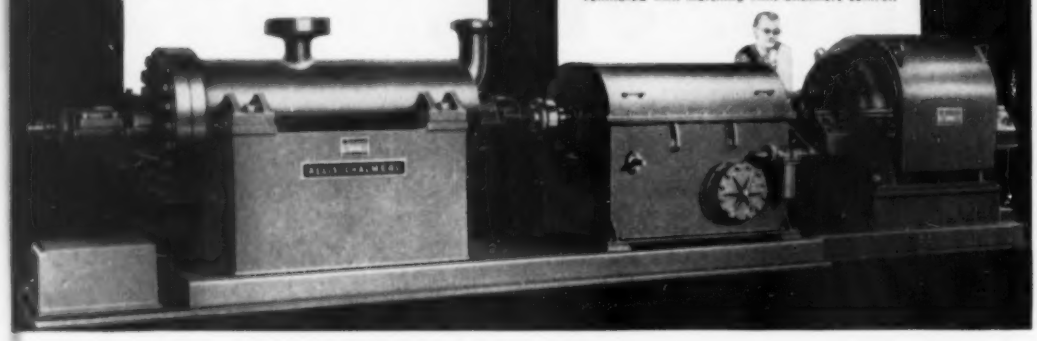
▶Back-to-back arrangement of stages and double volutes assure good axial and radial balance for high heads per stage. ▶Split inner casing simplifies maintenance. ▶Main horizontal joint of inner casing uses full hydraulic discharge to keep joint in compression. ▶Special design reduces possibility of flashing. ▶Uniform metal section thickness throughout volute casing equalizes expansion.

A-C 2-POLE MOTOR & CONTROL

The main thing you pay for and want in a boiler-feed pump drive is *reliability* . . . continuity of service with minimum time-out!

Here is how you get it in Allis-Chalmers two-pole motors: ▶Extra insulation protection built into the stator winding. ▶Improved bearing design eliminates oil leakage. ▶Bracket (housing) bearing construction results in easier mounting and alignment, greater rigidity. ▶Special, non-embrittling copper used in rotor rods. Rods silver brazed to end rings.

Available for indoor or outdoor application — drip-proof or splash-proof; water-cooled; tube-type totally-enclosed fan-cooled; or pipe-ventilated with *matching* Allis-Chalmers control.



HERE'S A COMBINATION that's hard to beat . . . a quality boiler feed pump, reliable 2-pole motor, and control — all Allis-Chalmers-*built* and *backed!*

CHOICE OF 3 TYPES OF PUMPS

At the pump end, depending on the head, capacity and pressure conditions you are figuring, you can select from 3 different designs:

☛the new barrel-type, for larger steam stations operating against the higher pressures, 1200 to 2500 lbs; 300 to 2000 gpm.

☛the "Doubleton", for pressures between 1200 and 1800 p.s.i.

☛or the standard Type "M", for pressures usually under 1200 p.s.i.

READ WHAT USERS SAY

Regardless of which type of pump you finally select, it will keep your maintenance costs down to a rock-bottom figure. Here's what power plant people, themselves, say.

After 45,000 hours, "No measureable wear on shaft sleeves, rings or internal parts." 1250 p.s.i., 735 gpm pumps at an Eastern utility.

After 82,000 hours, "Not .001 in. wear on any internal part." 6 x 4, 5-stage pumps at Midwest utility.

"Only .002 in. wear on rings" after 8 years operation on pumps installed in 1937. On the strength of this performance, this Ohio utility re-ordered three 1800 p.s.i. pumps.

And on three, 800 hp, two-pole motors driving boiler feed pumps in a Midwest utility, "In over 20 years of uninterrupted service we've had to order replacement parts twice at a total cost less than $12 a year!"

GET AN ALLIS-CHALMERS "PUMPING PACKAGE"

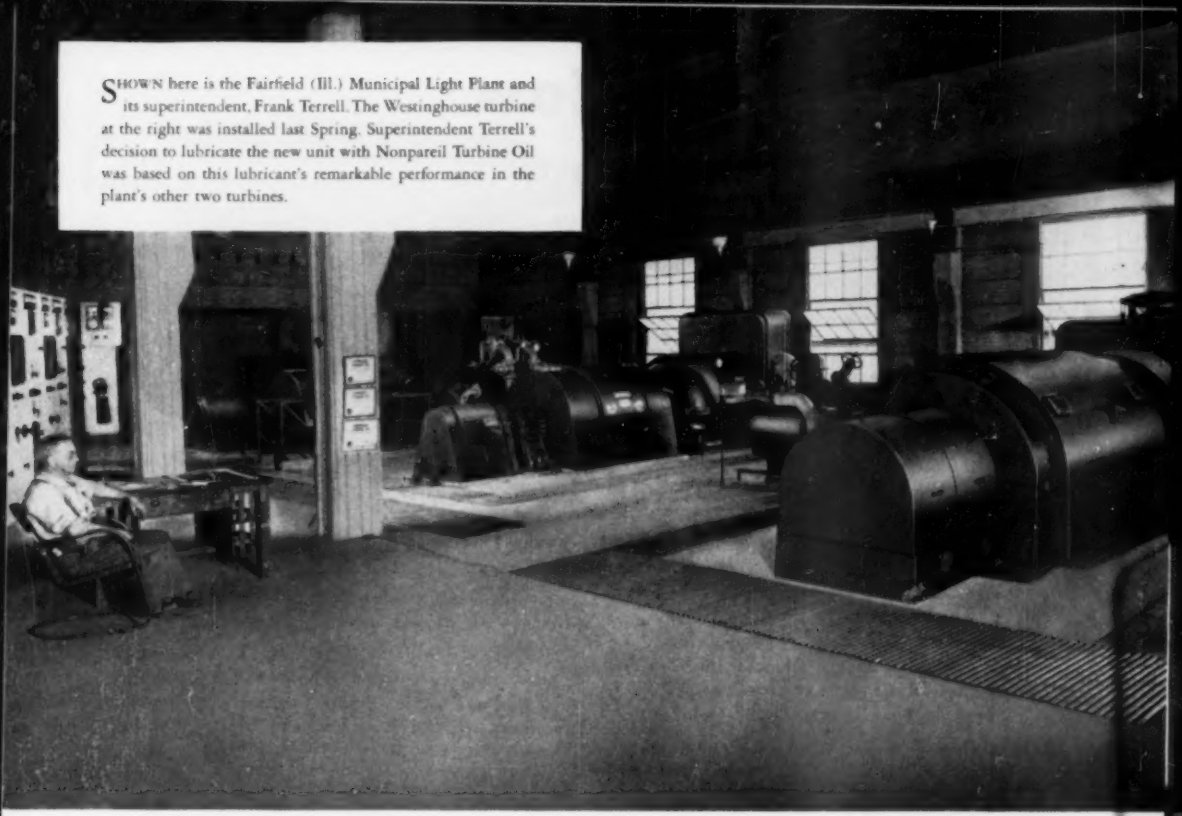
If you want this kind of performance in your power plant, get in touch with an A-C pump application engineer today.

He'll show you how a complete Allis-Chalmers "Pumping Package" . . . pump, motor and control . . . can keep you time, trouble and money ahead in the long haul.

A-2998

ALLIS-CHALMERS, 953A SO. 70 ST. MILWAUKEE, WIS.

ALLIS-CHALMERS



SHOWN here is the Fairfield (Ill.) Municipal Light Plant and its superintendent, Frank Terrell. The Westinghouse turbine at the right was installed last Spring. Superintendent Terrell's decision to lubricate the new unit with Nonpareil Turbine Oil was based on this lubricant's remarkable performance in the plant's other two turbines.

Here's minimum turbine-oil maintenance

CENTRIFUGING once a year is the only turbine-oil maintenance found necessary at the Fairfield Municipal Light Plant, Fairfield, Illinois. This practice has been followed ever since 1940, when Nonpareil Turbine Oil first went into the plant's new 1500-KW Westinghouse turbine. The same routine has been employed on a second Westinghouse unit of 2500 KW, installed in 1942.

During these 8 and 10 years of operation, the original fills of Nonpareil have not been removed either for treating or for replacing. Neutralization numbers have stayed below 0.08 mg KOH/gm. Oil systems have remained entirely clean.

Such lubricating economy and efficiency is not limited to 10- or 15-year records with Nonpareil Turbine Oil. Each fill of Nonpareil carries a written guarantee that it will remain below a neutralization number of 0.15 mg KOH/gm. *for the life of the turbine* it lubricates. 21-year service records of Nonpareil provide evidence of its ability to end acidity trouble and oil maintenance once and for all.

A Standard Oil Lubrication Engineer will be glad to supply you with actual case histories of utility operations in which Nonpareil Turbine Oil has reduced lubrication costs as much as 68%. Your letter will obtain the Engineer's services.

Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

NONPAREIL
Turbine Oil

"Will outlast your turbine"

STANDARD OIL COMPANY (INDIANA) STANDARD

Here's How to Erase Smoke Troubles

VIOLATION OF SMOKE ORDINANCE

LOSS OF FUEL ECONOMY

BAD COMMUNITY RELATIONS

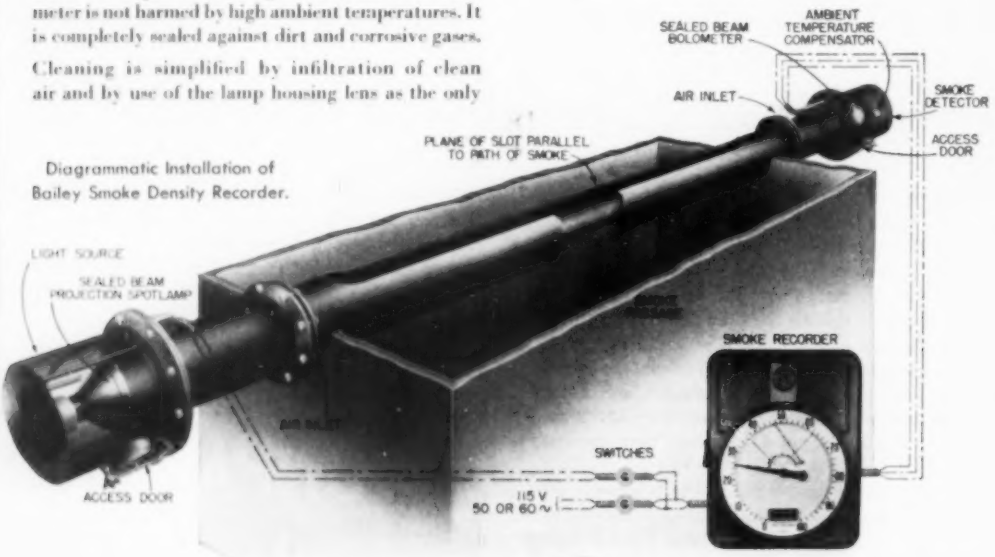
★ One of your first steps in erasing these troubles which result from excessive smoke, should be the installation of a Bailey Smoke Density Recorder. This 24-hour recorder is not an ordinary photo-cell instrument. Instead it detects smoke density by a Bolometer which is simply a sturdy tungsten filament and a parabolic mirror, mounted in a standard sealed beam automobile head lamp housing.

In using this simple, unique smoke detector, you do not have to provide cooling devices since the Bolometer is not harmed by high ambient temperatures. It is completely sealed against dirt and corrosive gases.

Cleaning is simplified by infiltration of clean air and by use of the lamp housing lens as the only window between the Bolometer and the gas passage.

It's easy to secure and maintain alignment of the sealed beam light source with the Bolometer since they are mounted at opposite ends of a slotted pipe which extends across the smoke passage.

For complete information on how you can profitably use this unique instrument to erase your smoke troubles, ask for Bulletin 211, "Bailey Smoke Density Recorder".



Diagrammatic Installation of Bailey Smoke Density Recorder.

G-29

BAILEY METER COMPANY

1040 IVANHOE ROAD, CLEVELAND 10, OHIO • BRANCH OFFICES IN PRINCIPAL CITIES

BAILEY METER COMPANY LIMITED, MONTREAL, CANADA

BAILEY METERS

Let Bailey Smoke Density Recorders Watch Your Stacks

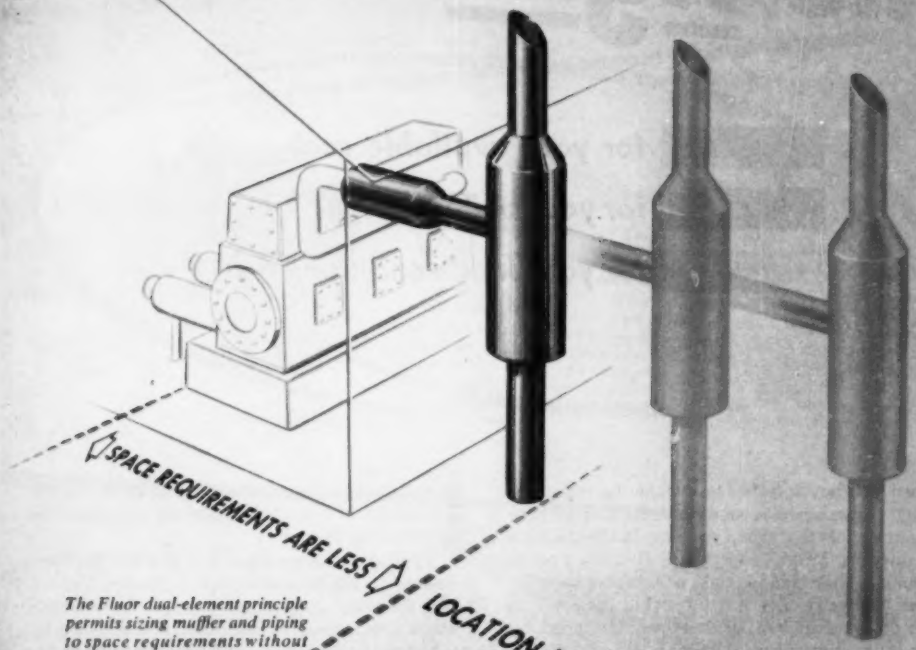
See for yourself...

the installation advantages of a FLUOR SERIES "D" MUFFLER SYSTEM

NO LONGER is ultimate muffling efficiency dependent upon trial-and-error locating of exhaust piping. With the Fluor Series "D," exhaust piping can be of *smaller* diameter, location of outside exhaust chamber *flexible* without affecting pressure drop or noise attenuation and pulsation reduction efficiency.

The reason lies in the unique dual-element design of this muffler *system*. Work is started on pulsative exhaust gases *at* the engine—noise and pulsation reflections are virtually eliminated *at* their source. The Fluor Series "D" Muffler is a *system* that incorporates *two* muffling elements—a primary element located in the immediate proximity of the engine and a secondary element located *at any desired spot* outside the engine room.

The Fluor Series "D" Muffler System is the answer to your muffling problems. In addition to installation flexibility it provides the highest muffling efficiency obtainable—*at a cost competitive with conventional mufflers.*



The Fluor dual-element principle permits sizing muffler and piping to space requirements without setting up hazards common to single-element mufflers.

All elements, including interconnecting piping, are engineered to a minimum in diameter.

Because muffling is spread throughout a Fluor Series "D" System, the outside muffling chamber can be set at any desired distance from the engine room wall.

AVAILABLE FROM STOCK—A Fluor Series "D" Muffler System to fit virtually any 2- or 4-cycle, 200 to 2400 HP diesel engine is available from stock. You need only submit engine room design and dimensions, make, model and RPM of engine and whether muffling system is to be air-cooled or non-air-cooled. Inquiries will be answered promptly.

THE FLUOR CORPORATION, LTD.

FLUOR

BE SURE WITH FLUOR

MANUFACTURERS of Mufflers, Pulsation Dampeners, Gas Cleaners, Cooling Towers and Fin-Fan Units.
DESIGNERS AND CONSTRUCTORS of Refinery, Natural Gas and Chemical Processing Plants.

2500 S. ATLANTIC BLVD., LOS ANGELES 22, CALIF.
Offices in principal cities in the United States
Represented in the Sterling Area by:
Head Wrightson Processes Ltd., Teesdale House, Baltic Street, London, E.C.1., England

C-E Assures you the right stoker

[redacted] for your available coal

[redacted] for your boiler design

[redacted] for your load conditions

When you buy a stoker you want the type best suited to *your specific requirements*. You are sure of getting just that when you turn to Combustion Engineering-Superheater. Why? Because a background of more than 20,000 C-E Stoker installations (above residence size) makes available to you an accumulated experience unmatched by any other stoker manufacturer.

In addition, Combustion offers you the most complete line of stokers available today . . . a line that meets every requirement of fuel and load conditions. Therefore, as the manufacturer of *all* types of stokers, Combustion can give you impartial advice in helping you select the *right* stoker.

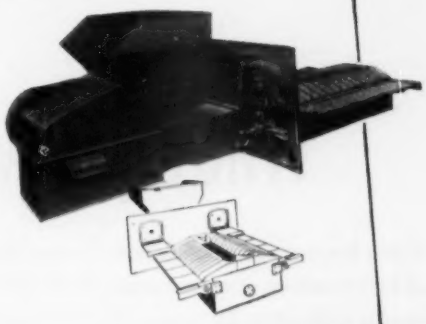
And at today's cost of coal, getting the *right* stoker can pay handsome dividends. For in an average installation the cost of coal used in a year exceeds many times the initial cost of the stoker. Thus the first cost of the stoker is soon absorbed by its saving in coal.

Typical of the complete C-E line are the three stokers on the opposite page — Skelly, Type E and Spreader. Each represents an outstanding value in its respective field. Each reflects the practical knowledge of fuels and operating conditions Combustion has gained through 60 years' experience in stoker design and application.

Day in and day out, all over the country, C-E Stokers are getting operating results as good or better than those anticipated at the time of purchase. In short, they are the *right* stokers for the job they were selected to do. So the next time you are in the market for stoker equipment, talk it over with Combustion before you buy. B-372

COMBUSTION ENGINEERING

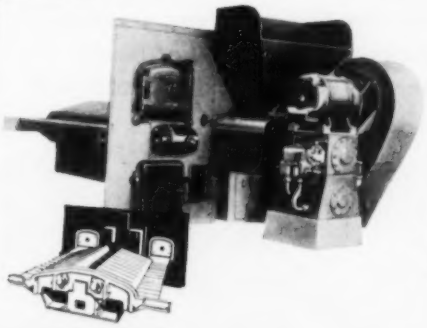
A MERGER OF COMBUSTION ENGINEERING COMPANY, INC. AND THE SUPERHEATER COMPANY



SKELLY STOKER UNIT

Approximate Application Range—20 to 200 boiler hp.

A compact, self-contained underfeed stoker available in designs for burning either anthracite or bituminous coal. An alternate arrangement of fixed and moving grate bars assures lateral distribution of fuel and maintains a clean porous fire. Cantilever dump grates of non-avalanching type simplify ash removal. An integral forced-draft fan, with inlet control, permits positive regulation of air-coal ratio. Sixteen rates of coal feed through variable-speed transmission. Automatic control is standard equipment. Timken bearing equipped. Alemite lubrication throughout.



TYPE E STOKER

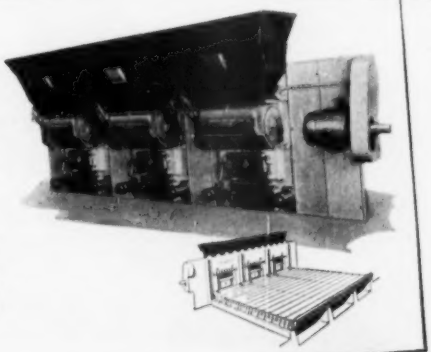
Approximate Application Range—150 to 600 boiler hp.

A single-retort, underfeed stoker designed to burn a wide variety of bituminous coals, particularly those having caking and coking characteristics. The Type E has ram type feed supplemented by a reciprocating sliding bottom. Its grate surface consists of hollow, air-cooled grate bars arranged in an alternately fixed and moving relationship to condition the fuel bed and assure its steady movement to the dump trays which are of the cantilever type. Air supply is under zoned control with provision for introduction of air over the fire. Type E Stokers are available with steam, electric or hydraulic drive.

SPREADER STOKER

Approximate Application Range—150 boiler hp. up to units producing 200,000 lb of steam per hr, or more.

The C-E Spreader Stoker is available in both dumping grate and continuous discharge types. This simple, rugged stoker is designed to burn a wide variety of coals. Hopper, feeding and distributing mechanism, variable-speed drive and motor are combined in a compact unit. Rotating spreader blades feed coal into the furnace in criss-crossing streams which assure uniform distribution. Fines are burned in suspension and the rest of the coal is burned on the grate. Grate surface is zoned for regulating air admission and to facilitate cleaning. All parts subject to wear are readily accessible for inspection, adjustment or replacement, when necessary. Rate of fuel feed and air supply may be regulated over a wide range and are readily adaptable to automatic control.



— SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.

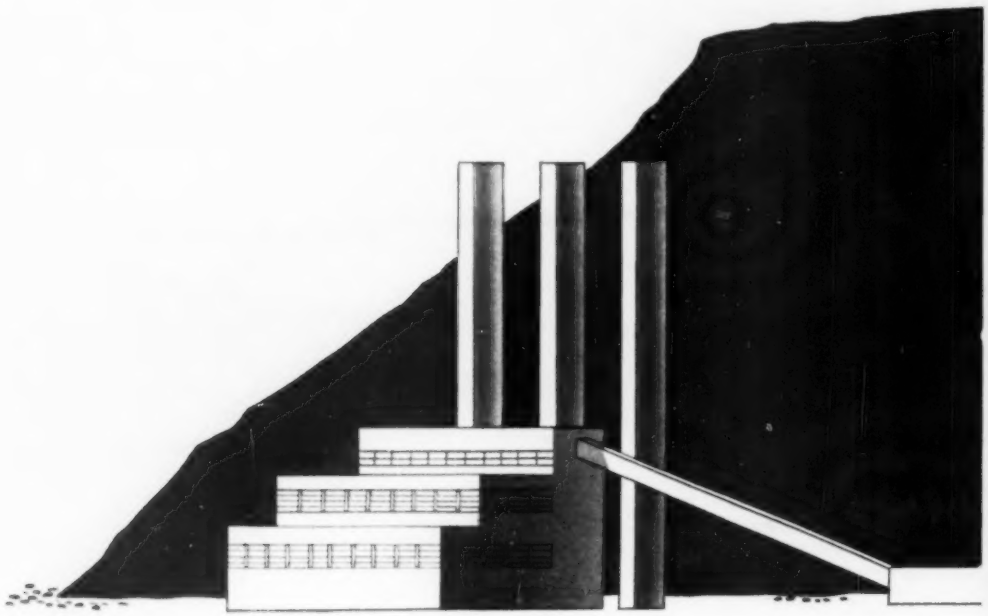
C-E

What part of $5,760,000 can

When you buy a combustion control system, the second best system is not good enough. No matter what it costs, it is too expensive. Too little air means unburned fuel, while too much air means heat wasted up the stack. Slight variations in either direction can, in a few years, cost more in wasted fuel than boilers and control system together.

Consider, for example, a 100,000 lb/hr boiler, running 24 hours a day, 300 days a year. Coal consumption will be roughly 5 tons an hour. At $8.00 a ton—a moderate price for coal today, even where freight rates are low—the fuel bill will be $960.00 a day, or $288,000 a year. Such a boiler will consume $5,760,000 worth of fuel in 20 years—and 20 years is a conservative estimate of the useful life of boiler and control.

If, in burning that fuel, your control system



HAGAN
HALL
BURGWIN
CALGON

you afford to throw away?

supplies too little air, combustion is incomplete. If it supplies too much, you spend money to heat up the sky. Either way, you lose.

Hagan Automatic Combustion Control Systems are designed for *precise* control. When they are placed in service, they are adjusted by Hagan's experienced combustion engineers, who make sure that you *get* the precision which is built into the control system.

Hagan controls are used on every size of boiler from 5,000 pounds per hour at 3 psi to 1,340,000 pounds per hour at 1800 psi. They have been applied to boilers burning oil, coal, gases of various types, even to boilers burning sawdust —and always with satisfactory results.

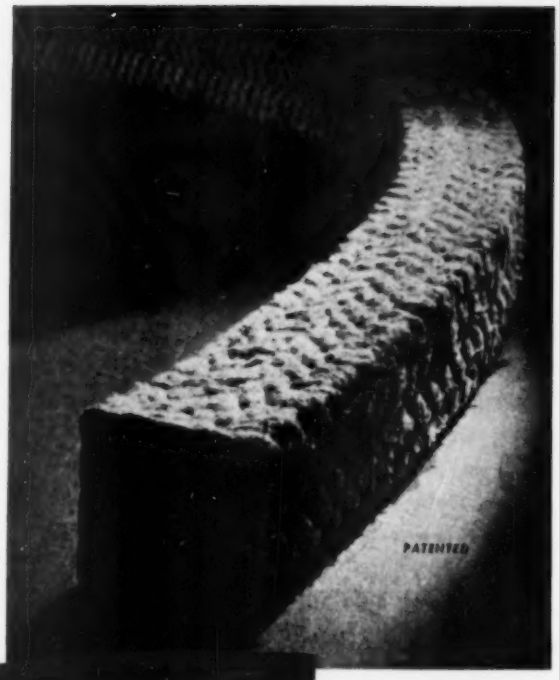
Our engineers will be glad to give you full information on Hagan control systems. Write to Hagan Corporation, Hagan Bldg., Pgh. 30, Pa.

HAGAN CORPORATION

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

QUESTION:

Which Garlock rod packing is braided through and through for longer life?



ANSWER:

LATTICE-BRAID

The unique structural design of LATTICE-BRAID packing gives it great strength, long life and unusual flexibility.

Supplied in several styles, including:

- GARLOCK 730 (asbestos)—for hot or cold water at medium to high pressures.
- GARLOCK 731 (asbestos)—for steam, gases or water at temperatures up to 700° F.
- GARLOCK 732 (asbestos—wire inserted)—for heavy duty service against steam, oil, gases or water at temperatures up to 700° F.
- GARLOCK 735 (asbestos)—for hot or cold water or alcohol at medium or low pressures.
- GARLOCK 734 (asbestos)—for cold gasoline, kerosene and light oils.
- GARLOCK 736 (blue asbestos)—for concentrated mineral acids.
- GARLOCK 740 (flax)—for cold water at medium or low pressures.
- GARLOCK 745 (flax)—for heavy hydraulic service against cold water.
- GARLOCK 751 (cotton)—for hot or cold water.

In GARLOCK LATTICE-BRAID *every braiding strand* passes diagonally *through* the body of the packing at an angle of approximately 45°. All the strands are strongly lattice-linked together into a structural unit which holds together even when the packing is worn far beyond the limits of wear of ordinary braided packings.

Write for folder!

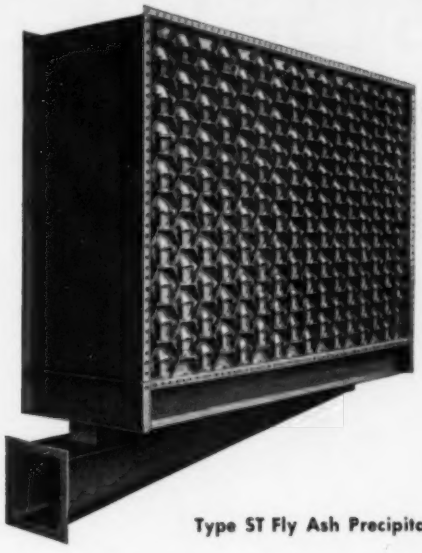
THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

GARLOCK

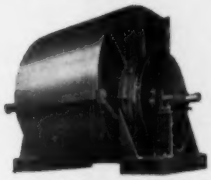
PACKINGS, GASKETS AND OIL SEALS

Solve your *fly ash problem* with an AMERICAN BLOWER FLY ASH PRECIPITATOR

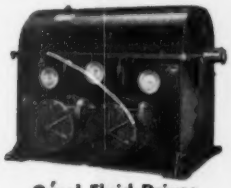


Type ST Fly Ash Precipitator

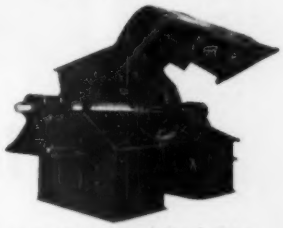
Heavy Duty Coils



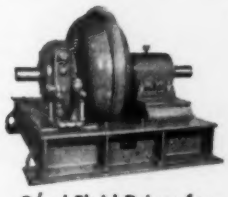
American HS Forced Draft Fans



Gyrol Fluid Drives for Boiler Feed Pumps



Sirocco Induced Draft Fans



Gyrol Fluid Drives for Mechanical Draft Fans

There are many advantages in using American Blower Type ST Precipitators for fly ash problems. Unique in design, simple in operation and low in maintenance cost, these units contribute materially to over-all power plant efficiency.

They automatically maintain high efficiency over the entire boiler load. Even at reduced loads, when fly ash is more difficult to remove, the Type ST Precipitator is relatively more efficient.

In addition, all element cells are die-formed, interchangeable and housed in a single, compact casing. Type ST units are flexibly designed to fit the job. They may be shipped for field assembly, or semi-assembled. They're available in a wide range of sizes to meet a variety of needs.

If you have a fly ash problem, why not call in an American Blower Field Engineer and work your needs out together? He has a wealth of experience behind him and excellent firsthand data at his disposal on Fly Ash Precipitators as well as on American Blower Heavy Duty Coils, Mechanical Draft Fans and Gyrol Fluid Drives for fan control and boiler feed pumps. Simply contact the nearest American Blower Branch Office—conveniently located in all principal cities.

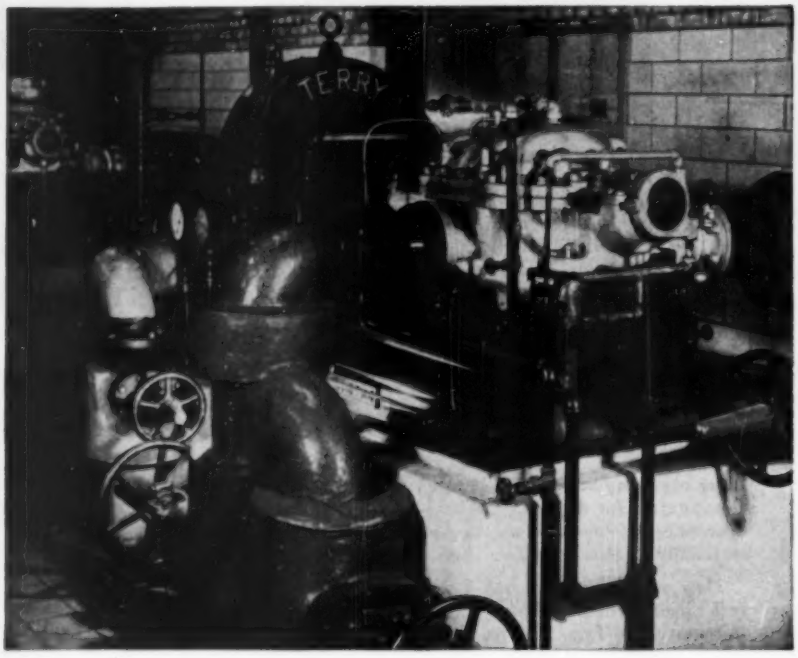
AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION

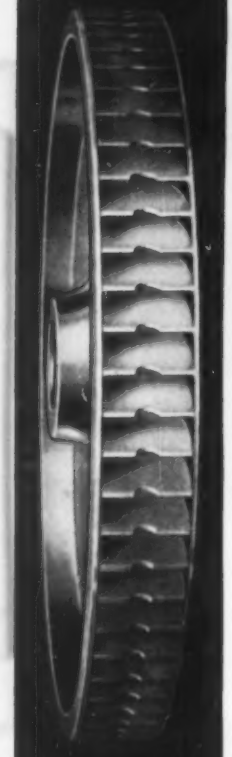
YOUR BEST BUY AMERICAN BLOWER POWER PLANT EQUIPMENT

Serving home and industry

AMERICAN-STANDARD · AMERICAN BLOWER · CHURCH SEATS · DETROIT LUBRICATOR · KEWANEE BOILERS · ROSS HEATER · TONAWANDA IRON

TERRY





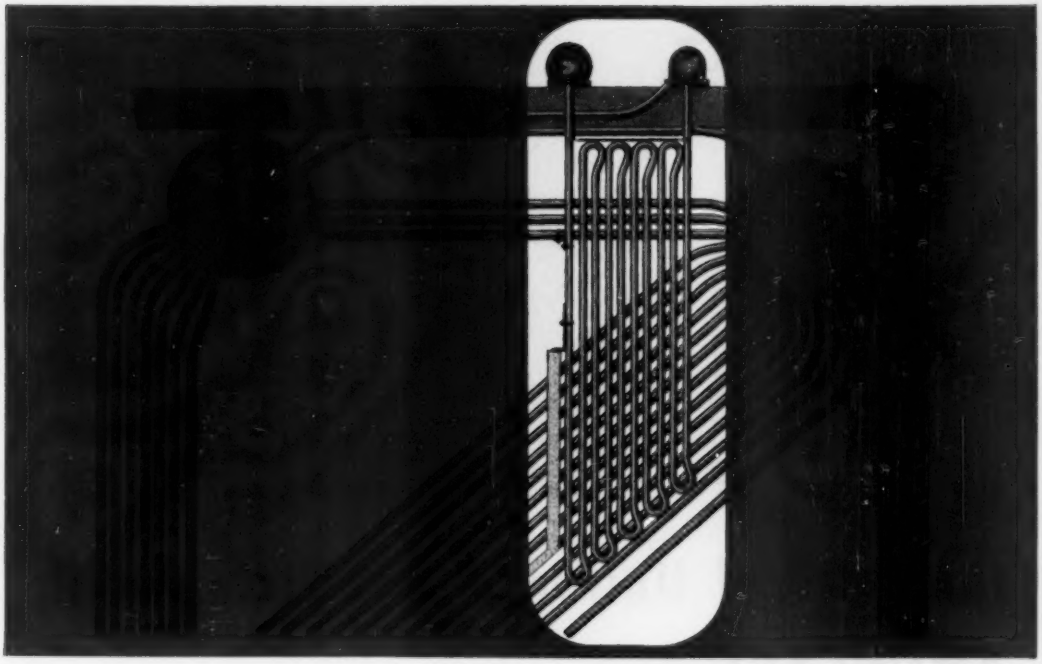
110hp Feed Pump Turbine with Large Safe Clearances

The blades of this turbine are milled out of a one-piece forged-steel wheel with generous clearance both radially and axially. The side clearance is very large — one inch — and the blades are protected by a projecting rim on each side of the wheel. It is therefore impossible for the blades to foul and end play can do no damage to the turbine.

These are but a few of the features that make the Terry Solid-Wheel Turbine such a dependable driver. A bulletin giving other interesting facts about this turbine will be sent upon request.

T 1179

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.



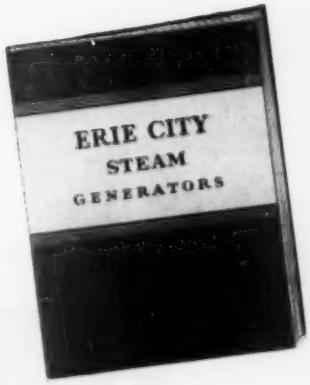
THE ERIE CITY SUPERHEATER

The illustration above shows one of the many types of superheaters designed and produced by Erie City to meet the exacting requirements of the modern steam generator. This particular example is the vertical pendant type.

The horizontal steam take-off serves also as the superheater inlet header, thus making the superheater an integral part of the boiler and simplifying installation and maintenance.

This familiar method of taking steam from an Erie City boiler in a transverse series of tubes, instead of a single nozzle, produces steam with high initial dryness and allows the superheater to perform with maximum efficiency and safety.

Our Steam Generator Bulletin (SB-30) illustrates and describes many types of superheaters engineered and manufactured within our own plant. It is available on request.



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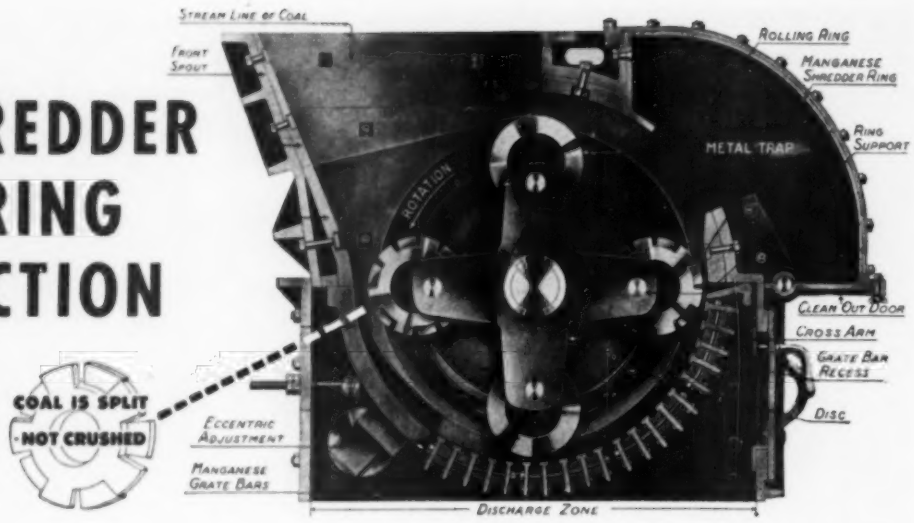
Complete Steam Generators • Type C 3-Drum Boilers • Type VL 2-Drum Boilers • The "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • Coal Pulverizers • Underfeed and Spreader Stokers • Welded Pressure Vessels for the Process Industries.

ERIE CITY IRON WORKS • ERIE, PA. • *Since 1840*

SHREDDER RING ACTION



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Efficient coal firing depends upon uniform sizing. That's why so many power plants use American Crushers—with exclusive Shredder Ring Action. Thrust outward against the coal by centrifugal force, the flexible rings maintain constant, controlled contact . . . to *split the coal—not crush it.* The result is a uniform product with controlled fines that assures a loose, uniform, *quickly responsive firebed*—without excessive ashpit drop or unnecessary CO_2.

Minimum headroom requirements and independence from auxiliary crushing permit easy, economical installation without extensive alterations.

SHREDDER RING

ROTOR

American Crusher's manganese steel shredder ring and rotor assembly—for rapid reduction at low, power-saving speeds. Each ring has 20 cutting edges . . . revolves on individual shaft, free to deflect from tramp iron without damage.

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In a pamphlet that belongs under the glass on your desk top we've condensed a part of our knowledge on the use of AMBERLITE IR-120 in water softening. The extremely high capacity of the resin, even when operated at low regeneration levels, is described. The effects of flow rates and water temperatures on headloss and expansion are tabulated. And we've squeezed into 5 tables and 811 words a description of the resin that resists acid, alkali, chlorine, heat, attrition, and waters low in silica.

If you plan to install a new high-capacity softening unit or if you want to replace zeolites of low capacity with a resin of high capacity and efficiency, you owe it to your boilers to write Department PGI-2 for your copy of the pamphlet on AMBERLITE IR-120.

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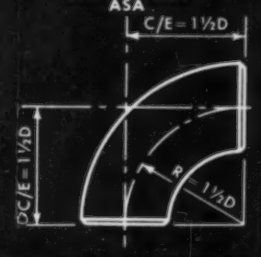
Improvements and economies in welded piping result from this *Variety* of MIDWEST ELBOWS

1

LONG RADIUS ASA

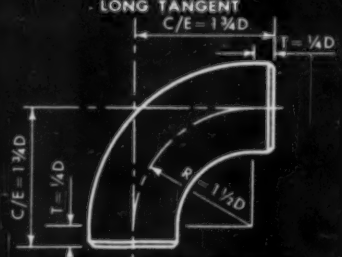


SIZES: ¾" TO 24", INCLUSIVE

Dimensions conform to applicable size range of American Standard for Butt-Welding Fittings, ASA B16.9. Radius and center-to-end dimension equal 1½ times nominal pipe size.

2

LONG RADIUS LONG TANGENT

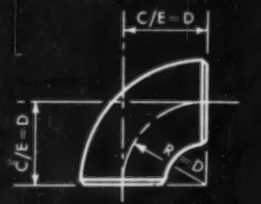


SIZES: 2" TO 20", INCLUSIVE

Same radius as ASA Elbows but with long integral tangent on each end — an exclusive Midwest feature that saves time and pipe. No price increase over ASA Elbows.

3

SHORT RADIUS

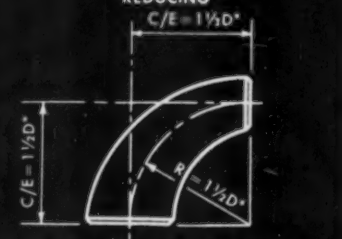


SIZES: 1" TO 30", INCLUSIVE

Where space limitations prevent use of ASA Elbows or Midwest "Long Tangent" Elbows shown above at right, these short turn elbows without tangents are recommended.

4

LONG RADIUS REDUCING



SIZES: 2" TO 12"*, INCLUSIVE

Midwest Reducing Elbow takes the place of a straight elbow and a reducer. It saves more than one-third of the welding and improves both design and appearance.

SYMBOLS { *C/E—Center-to-End Dimension* / *T—Length of Tangent* } *D—Nominal Pipe Size* *R—Radius* **D—Dimension is for larger Pipe Size*

MIDWEST WELDING FITTINGS Improve Piping Designs and Reduce Costs

90° ELBOWS

REDUCING 90° ELBOWS — 45° ELBOWS

LAP-JOINT STUB ENDS — REDUCERS

CAPS — SADDLES — SLEEVES

RETURN BENDS — TEES

LATERALS — CROSSES

REDUCING-ON-RUN TEES

SHAPED NIPPLES — FLANGES

The *variety* of Midwest Welding Elbows is particularly important because of the exceptional latitude in design and economy in erection that it provides. For example, the Midwest Long Tangent Elbow permits faster, easier, more accurate lining up with pipe . . . removes weld from point of maximum bending stress . . . often eliminates a short nipple and its extra weld. Slip-on flanges are easily used with minimum change in flange and fitting.

This "Variety" is only one of several reasons why many users prefer Midwest Welding Elbows.

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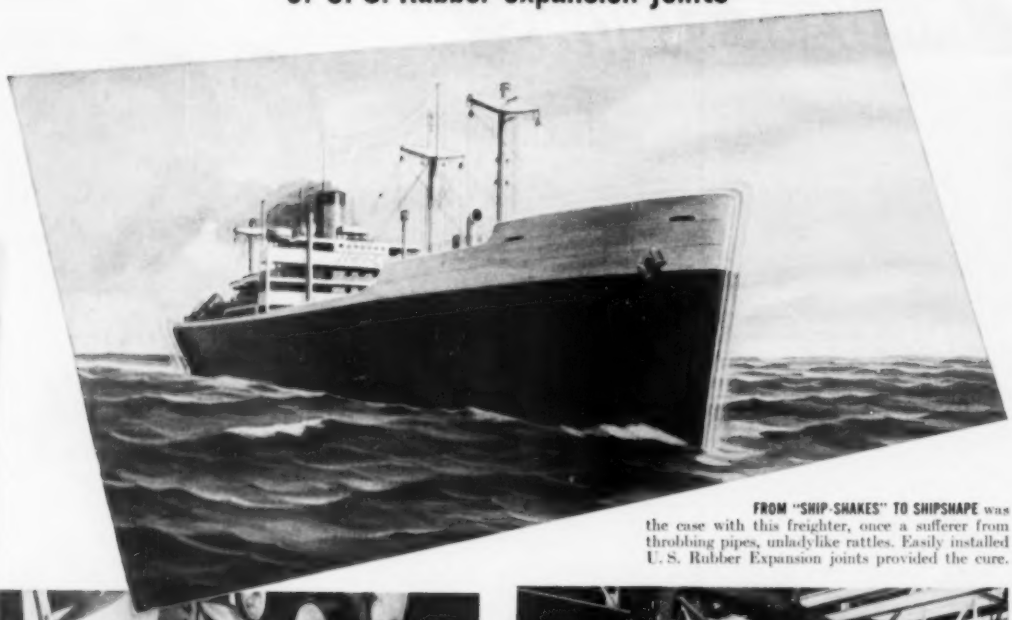
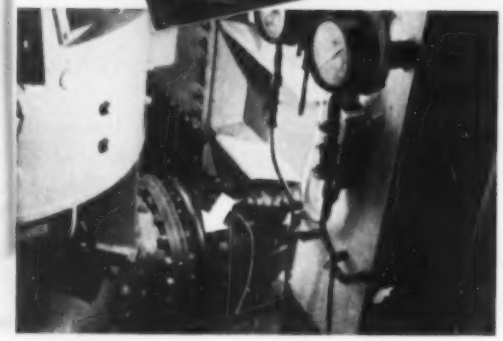
Chicago (3), 79 West Monroe St. • Los Angeles (33), 520 Anderson St. • Houston (2), 229 Shell Bldg. • Tulsa (3), 533 Mayo Bldg. South Boston (27), 426 First St. • Distributors in Principal Cities.

THE CASE OF THE NERVOUS SHIP

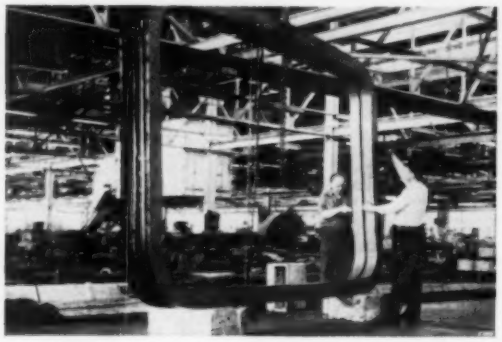
Vibrations and noise in her pipe systems eliminated by installation of U. S. Rubber expansion joints



FROM "SHIP-SHAKES" TO SHIPSHAPE was the case with this freighter, once a sufferer from throbbing pipes, unladylike rattles. Easily installed U. S. Rubber Expansion joints provided the cure.



A CASE IN POINT shows compact U. S. Rubber Expansion Joint between circulating water pump and ship's condenser. It allows maximum expansion and contraction in normal operations.



KINGSIZE JOINT was developed for use between turbine and condenser in central power stations. Only U. S. Rubber, the originator of rubber expansion joints, has built reliable joints as large as this.

United States Rubber Co. engineers can design and build joints to meet your special conditions . . . can make practical recommendations for their use to take care of expansion, vibration and elimination of noise transmission, and to provide resistance to fire. Write Mechanical Goods Division,

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It's here now! The remarkable motor oil from the giant new $42,000,000 lubricating oil plant at Lake Charles, La. The plant that's been the big talk of the oil industry for months.

New Premium Koolmotor is made by the unique "Heart-Cut" Process which retains only the choicest part of the finest crudes. *It's so superior that in recent engine tests it outscored nine other major premium motor oils.* No wonder Premium Koolmotor is better in every way! Cleans better, seals better, cools better and fights acid, sludge and corrosion far more effectively. Switch to this remarkable new oil today.

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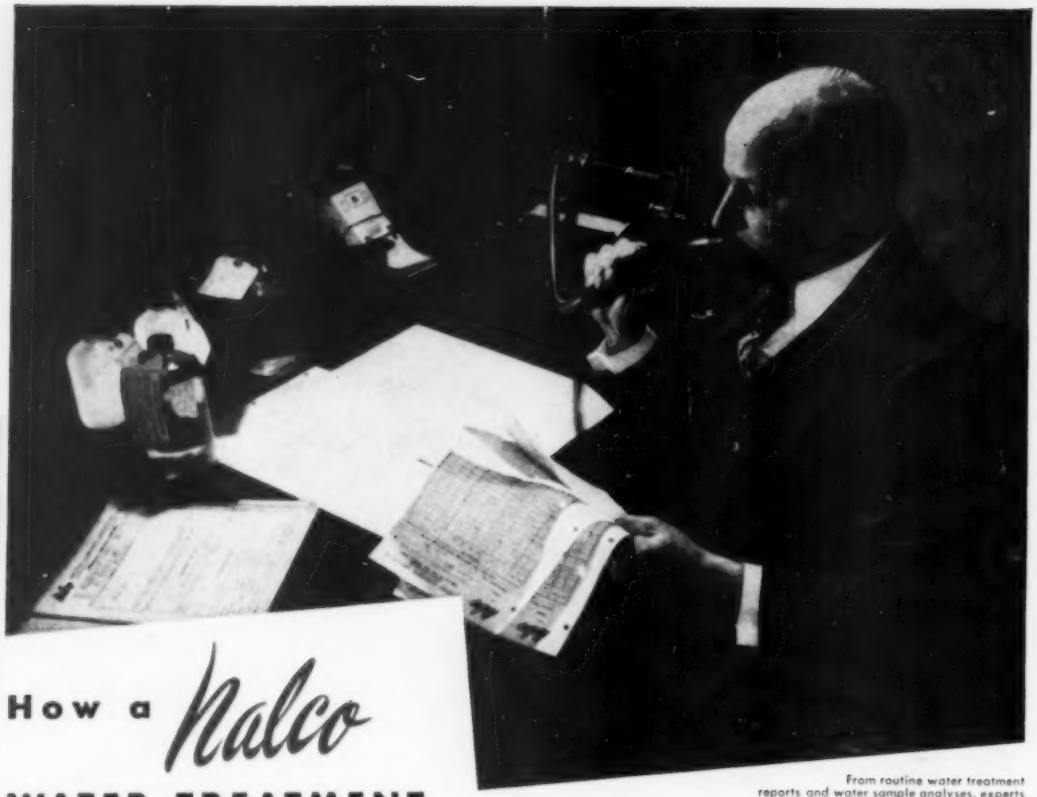

From routine water treatment reports and water sample analyses, experts at Nalco Laboratories keep a complete record of your plant water treatment — can assist materially in maintaining permanent water treatment security.

How a *Nalco* WATER TREATMENT SERVICE AGREEMENT WORKS FOR YOU

OPERATION of your plant under a Nalco Water Treatment Service Agreement gives you two important safeguards against water treating problems in any form. First, Nalco will provide proper water treatment chemicals and procedures. Second, an experienced Nalco Service Representative will make regular visits to your plant, and is on call at any time to deal promptly with emergencies. Whether you have 10 or 10,000 BHP, this combination will provide what thousands of Nalco System users have learned to take for granted: *permanent water treatment security.*

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HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

ELECTRICAL

101 Small Power Transformers—The manufacturing procedure for company's small power transformers is revealed in 28-pp Bulletin 61B6084A. Describes core and coil unit, no-load tap changer, tank construction, cooling methods, oil preserving systems, bushings, terminal compartments indicators and testing of single phase transformers, 69,000 v and below up to 5,000 kva, and three-phase transformers 69,000 v and below up to 15,000 kva. Includes table of preferred voltage ratings for step-down power transformers and photos of typical installations. Allis-Chalmers Mfg. Co.

102 High Speed Synchronous Generators—Bulletin GEA 5415 deals with generators for standby, portable and prime source power in wide-spread fields of application. Profusely illustrated, it gives three typical installation stories, describes protection afforded, and tells about construction features, mechanical modifications, and performance data. General Electric Co.

103 Small Electric Generating Plants—Eight-pp Form A-1068H covers a line of gasoline-driven electric plants for institutions, construction projects, standby service and other applications. Those described and illustrated range from 200 to 35,000 w in standard voltages, frequencies and phases. Also listed are battery charging electric plants in 6, 12 and 32 v, 400 to 2000 w, and special accessories. A general information section gives selection pointers. D. W. Onan & Sons, Inc.

104 Safety Switches—Folder TEC 10, 4 pp, gives information about company's high capacity interrupter safety switches for use in industrial distribution systems. A detailed explanation of the arc-quenching action of the grid pin design is illustrated by several schematic drawings. Other features described include center-front operation, front fusing, and a roller-cam action and special linkage design. The Trumbull Electric Mfg. Co.

105 Aluminum Bronze Electrodes—"Cutting Maintenance Costs with Aluminum Bronze Electrodes." is the subject of a 4-pp article by Joseph A. Cunningham. It describes the successful salvage and repair of worn or broken parts. Such parts as pump shafts, gears, clutch pinions, cable idlers, overhead crane track are mentioned. Illustrated with photos of repair jobs. Ampco Metal, Inc.

106 Flexible Terminal Blocks—This 4-pp bulletin provides test results, physical and electrical specifications and dimensional data on an easily-used system of interlocking units that may be added to terminal blocks in any number at any time. Includes prices of points, end pieces, marking strips and cover pieces. Wasma Co.

107 Synchronous Motors—Publication GEA-5436, 8 pp, lists some of the applications for manufacturer's high-speed synchronous motors. Illustrated with many photos, the bulletin gives three typical installation stories, describes protection, and discusses construction features, mechanical modifications, and direct-connected exciters for the motors. Covers two- and three-phase type motors in ratings from 20 to 1500 hp at 60 cycle speed of 1800 rpm, as well as proportional hp ratings for speeds through 514 rpm. General Electric Co.

PIPING, VALVES AND ACCESSORIES

108 Pipe Sizing Tables for Steam and Water—Four-pp folder; on the inside pages, in tabular form, three multipliers by use of which you can quickly and accurately find pipe size for flow of steam and water at any pressure and temperature and any allowable pressure drop, all developed by A. B. Stickney, and previously published in Power Generation. Takes account of resistance of valves and fittings to flow of fluids. Complete instructions for use of the multipliers, with examples. Everything you need for quick, accurate pipe sizing on two pages for your notebook or file. The Rust Engineering Co.

109 Rubber-Lined Piping—Catalog Section 9700 on rubber-lined pipe, fittings and valves gives the design and construction features and service recommendations, lists uses, and describes and pictures the products. Includes specifications, dimensional data. The B. F. Goodrich Co.

110 Valves, Lubricators and Piping Accessories—Here's a condensed catalog covering, briefly, several types of valves, hose assemblies and connections, filters, regulators and lubricating units. Illustrates equipment, tells applications, sizes. C. A. Norgren Co.

111 All-Purpose Valves—Illustrated Bulletin 501, 4 pp, describing in detail a series of globe and angle globe stop valves, gives design details, dimensional data, material specifications. Also includes list prices for these forged steel valves in both 800 and 1500 lb sp classes. Edward Valves, Inc.

112 Steam Trap Selection—Contending that there is no universal steam trap, Selection Chart 1600, 4 pp, describes and illustrates thermostatic, inverted bucket, float thermostatic, and liquid expansion types giving advantages and recommendations for use. Includes table showing first and second choice of trap types for 34 applications. Sarco Co., Inc.

113 Sheet Packing Data—Various types of sheet packing manufactured for handling liquids, gases and abrasives are presented in Bulletin 5000, 4 pp. It lists specifications and outlines uses of the different kinds of packing and describes materials used in their construction. The B. F. Goodrich Co.

PUMPS, COMPRESSORS

114 Sewage and Trash Pumps—Bulletin 5400E-1, 16 pp, features details of construction and drive modifications possible with company's vertical shaft and horizontal shaft bladeless pumps, and is generously illustrated with photos of pumps and sectional drawings. Includes general discussion of pumps, typical specifications, dimensional data, selection tables and performance characteristics chart. Fairbanks, Morse & Co.

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115 **Flow Pumps**—Data Sheet 04 gives 8 pp of illustrated information on a new 5-in. stroke, 5-cylinder, direct-flow pump. Information presented includes construction and design details, general specifications, dimensional drawings, selection chart and table and drive specifications. The Aldrich Pump Co.

116 **Compressibility Charts**—Bulletin P-7697 is a 32-pp technical discussion of compressibility charts and their application to problems involving pressure-volume-energy relation for real gases. Contains chapters on real gases, horsepower equations for a real gas, and flow through nozzles. Includes several examples of reduced pressure charts. Worthington Pump and Machinery Corp.

WATER TREATING

117 **Boiler Water Treatment**—Elsey company's engineering and technical staffs are prepared to offer complete, individualized service in the analysis and treatment of boiler water is discussed in this 8-pp brochure. Generously illustrated with photos, it also comments briefly on external and internal treatments which may be needed. R. F. Drew & Co., Inc.

118 **Hydrogen Zeolites in Water Softening**—Described as one of the few reports published on the results obtained from organic zeolites in the hydrogen cycle with acid regeneration in Article TA-113, 13 pp, written by V. J. Calise. In addition to presenting operating data from several commercial hydrogen zeolite installations, the paper also explains applications of acid-regenerated zeolites, compares sulfonated coal type and resin type zeolites and discusses factors involved in establishing conditions on effectiveness of this method of water softening, including silica removal. Includes tables of results obtained and charts showing characteristics of zeolites. Graver Water Conditioning Co.

MECHANICAL POWER TRANSMISSION

119 **Speed Reducers**—Illustrated Catalog 46-B is a 44-pp comprehensive ordering book on parallel shaft, continuous tooth herringbone speed reducers of both 45° single-gear offset drive and double-gear straight-line drive types. Discusses design advantages of company's speed reducers, gives general specifications, explanation of rating tables, ordering tips and selection data. Full dimensions and ratings are provided and current price list folder is included. D. O. James Mfg. Co.

120 **Transmission Belting Manual**—Answers to most of the questions on transmission belting are provided in this 36-pp book. Illustrates company's beltings, gives specifications, tells how to select correct type for the job; also how to order belting, install it and maintain it in good operating condition. Filled with technical data, including comparisons, useful formulas, tables of belt speeds, overload and correction factors. Republic Rubber Div., Lee Rubber & Tire Corp.

INSTRUMENTS AND CONTROLS

121 **Combustion Safeguard**—Bulletin P2-1 is a 4-pp folder on company's new safeguard for oil and gas fired furnaces, ovens, boilers, kilns and other heating equipment. The safety features and economy of the new control are described and illustrated and a typical application diagram is included. Bulletin also includes selection chart covering several control units. Wheelco Instruments Co.

122 **Flow Gage**—Catalog 86, 4 pp, introduces company's low cost, flow rate indicator for ecolants, lubricants, opaque liquids, slurries and other fluids. Tells how gage is used where it's applicable. Includes photo and sectional drawing of instrument; discussion of its design, and full dimensions, specifications and flow rate and pressure data. Fischer & Porter Co.

123 **Time Cycle Controllers**—Sixteen-pp Bulletin 98154 features an instrument adaptable to applications which have a multiplicity of functions to perform during the course of a cycle. Describes five models for applications requiring all-electric or all pneumatic operation or combinations of each, showing how they control a group of functions required in the sequence of a manufacturing operation according to a predetermined schedule and over a timed period. Photos of complete instruments, sectional views and application drawings included. Taylor Instrument Companies.

124 **Instrumentation for Steam-Operated Generating Stations**—Bulletin 80-1, 31 pp, features company's continuous balancing electronic potentiometers. Also describes and illustrates pneumatic transmission for high pressure measurement designed to centralize remote measurement with safety. Includes a large diagram of typical temperature and pressure measurement points in a steam boiler and turbine generator. Information on pressure gages, thermometers, thermocouples, pH and conductivity electrodes, flow or liquid level meters and control valves and auxiliaries are also presented. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

METALS

125 **Ferrous Metallurgy Chart**—Again available to power engineers is company's popular "Basic Guide to Ferrous Metallurgy," recently reprinted. This chart shows wrinkling characteristics of steels in temperatures from —300 F to 2000 F. All important temperature zones, including hot working, annealing, normalizing, stress relieving, carburizing and preheating for welding are clearly defined. Temperature ranges are shown in 19 colors approximating the characteristic hot-body radiant hues. At the right of the chart 23 fundamental metallurgical terms are defined and explained. A diagram symbolizing change in grain size with temperature is included. This plastic laminated chart measures 18½ by 21 in. and can be cleaned easily. Tempil Corp.

126 **Steels for Hot Spots**—This is an 88-pp manual filled with information on steels for elevated temperature service. Includes a discussion of the general principles of high temperature behavior of ferrous materials and the factors influencing their behavior; a data section replete with tabular and graphical material covering mechanical property values of 21 steels; an illustrated description of major high temperature testing facilities in the United States, and a comprehensive bibliography of company's technical publications on the properties and use of steel at high temperatures. United States Steel.

127 **Heat Resistant Steels**—Steels with improved chemical and acid corrosion resistance are the subject of this folder. Includes information on their tensile strength, weldability, structure and electrical conductivity. Also contains photos showing effects of etching with aqua regia and picric acid on these and other metals. Universal Research Corp. of America.

128 **Bronze Bars**—This 6-pp bulletin announces manufacturer's expanded line of cored and solid "Tiger" bronze bars in popular sizes, both rough and machined. Lists sizes and weights of the bars, shows physical properties of the material, describing its uses and its advantages of wear and shock resistance and anti-fric-

(Continued on page 120)

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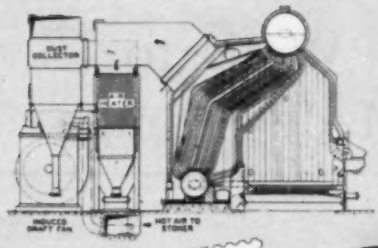
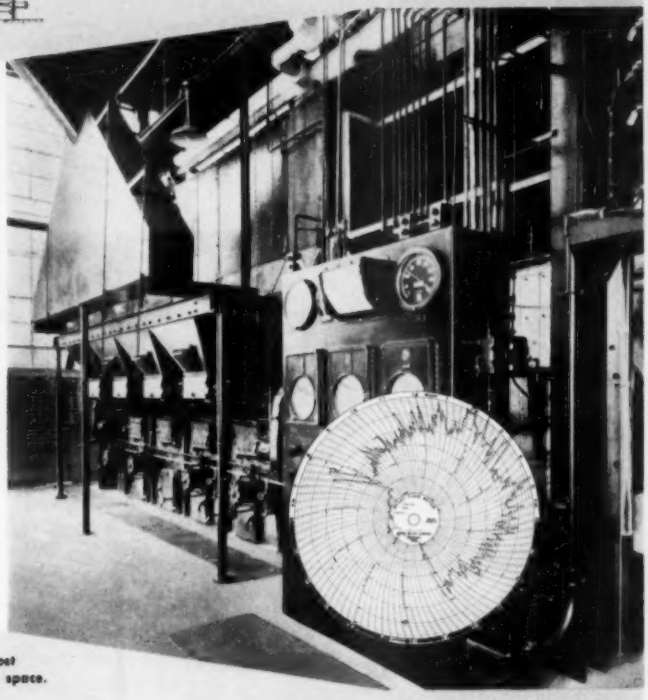


B&W Integral-Furnace Boiler, Type FF, at Hanes Dye and Finishing Company. Steam capacity is 40,000 lb. per hr. at 125 psi, with provision for future operation at 250 psi and with the addition of a superheater.

Another Example of B&W Engineering for Economy



Compact, single-level arrangement of boiler and auxiliary equipment with one-point control, provides utmost accessibility and ease of operation in minimum space.

. . . 20% more steam

. . . 37% less space

. . . 20% fuel saving

Hanes Dye and Finishing Company, Winston-Salem, N. C., recently installed a single spreader-stoker-fired B&W Integral-Furnace Boiler, Type FF . . . in 37% less floor-space than was occupied by four existing units having 1/5 less total capacity. High efficiency is maintained over a wide range of coals, including low grades, resulting in estimated fuel savings of 20%. Operating over a daily load range of 12 to 1, the new boiler easily handles instantaneous load swings of 5 to 1 with close control of pressure and steady water level, as compared to pressure drops as much as 40 psi in the old units. Heavy maintenance costs experienced with the previous installation have been eliminated.

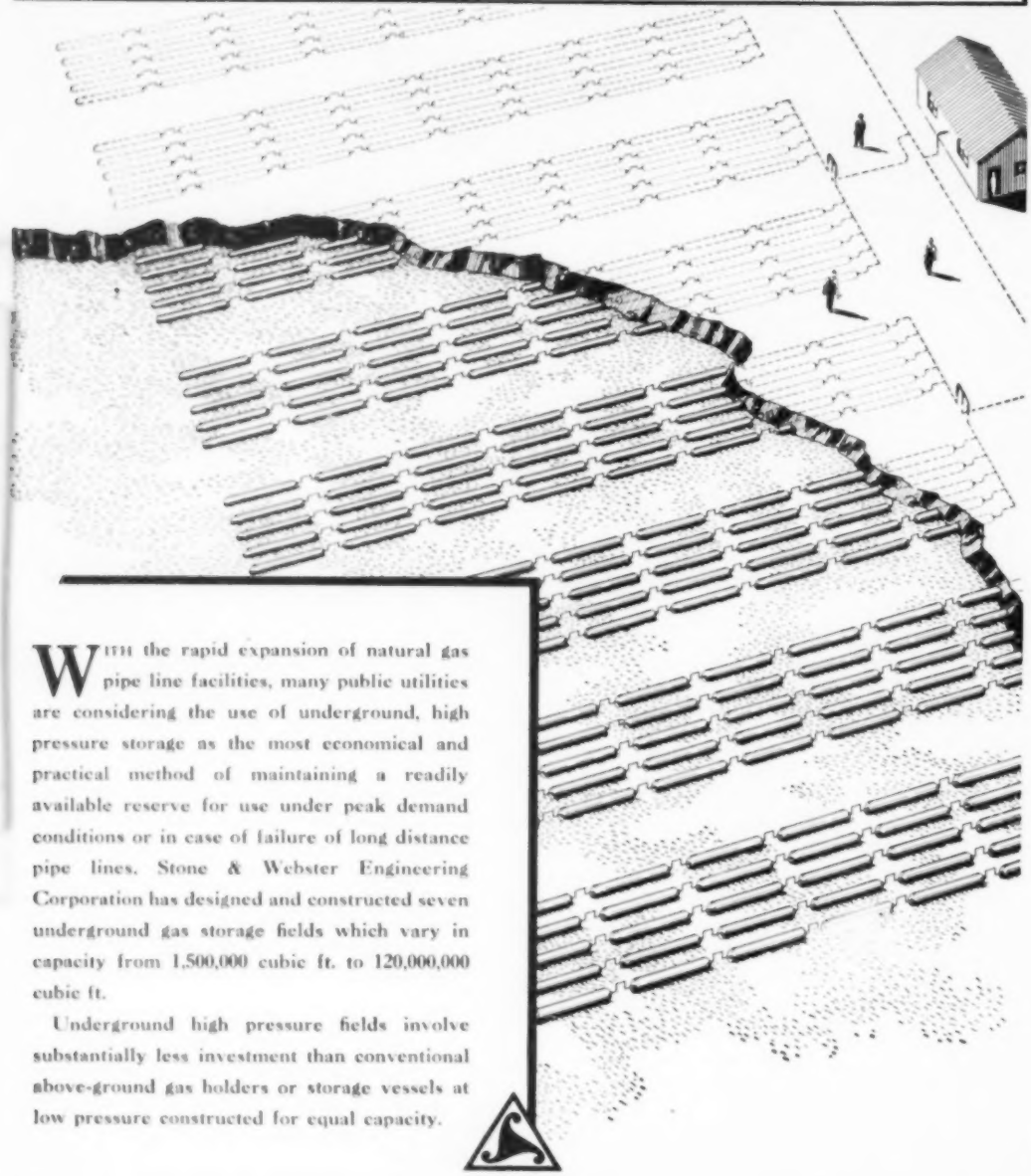
Dollars and cents benefits usually follow B&W's participation in boiler modernization for *any* type of plant. It will pay you, as it has so many other industrial, commercial, and institutional users, to investigate the modern B&W Integral-Furnace Boiler, Type FF, for steam capacities up to 60,000 lb. per hr. Start by writing for Bulletin G-64. The Babcock & Wilcox Company, 85 Liberty Street, New York 6, New York.

B&W

BABCOCK & WILCOX

G-461

From Nature's Gas Wells to Man Made Storage



With the rapid expansion of natural gas pipe line facilities, many public utilities are considering the use of underground, high pressure storage as the most economical and practical method of maintaining a readily available reserve for use under peak demand conditions or in case of failure of long distance pipe lines. Stone & Webster Engineering Corporation has designed and constructed seven underground gas storage fields which vary in capacity from 1,500,000 cubic ft. to 120,000,000 cubic ft.

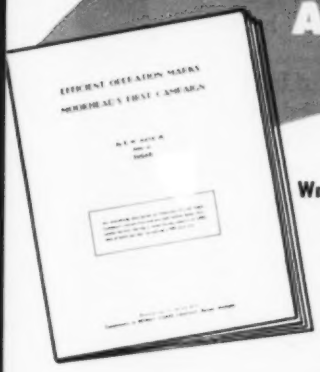
Underground high pressure fields involve substantially less investment than conventional above-ground gas holders or storage vessels at low pressure constructed for equal capacity.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY OF STONE & WEBSTER, INC.

AMERICAN CRYSTAL SUGAR COMPANY
Moorhead, Minnesota

ANOTHER FOOD PLANT MAKES SAVINGS WITH DETROIT STOKERS



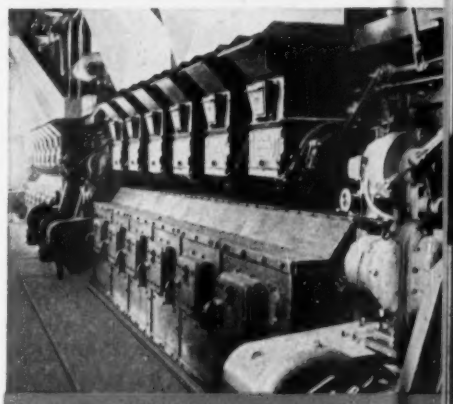
Write for this "Sugar" article

Heat is a major item in food processing. Fuel, therefore, is one of the main expenses. Coal, the "Basic Fuel," burned with Detroit Stokers is the Most Economical Method of Producing Heat. That's why leading Food Plants use them.

American Crystal Sugar Company uses ten Detroit Stokers in three Plants.

For their Moorhead, Minnesota Plant, they selected Detroit RotoGrates for two 110,000 pound steam generating units to process up to 3,000 tons of sugar beets a day.

An important factor in their decision was the necessity of being able to provide dependable steaming capacity with either 13,500 Btu Eastern Bituminous Coal or 6,800 Btu North Dakota Lignite, and to change readily from one fuel to the other if desired. The Lignite, burned has 29% moisture and 38% volatile.



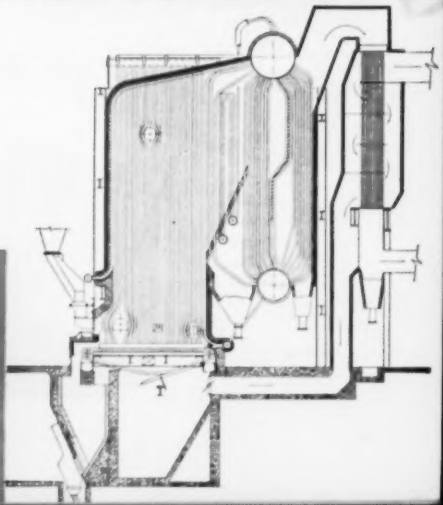
Detroit RotoGrate Stokers applied to 110,000 pound two drum steam generators. Designed for air preheat up to 360° F.

Popular With Engineers

Cleanliness of Detroit RotoGrate firing combined with ability to handle fluctuating loads also appeals to Food Product Engineers.

You, too, can benefit by these operating advantages. Investigate now—no obligation.

WRITE FOR CATALOG TODAY



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OTHER TYPES AND SIZES OF DETROIT STOKERS FOR EVERY INDUSTRIAL OR POWER NEED

PLUGS ARE OUT WITH CHLORINATION

Costly plug cleaning, with its high labor bills and lengthy equipment down-time, goes out of the condenser and heat exchange picture the minute chlorination arrives.

This proven process for cutting the costly effects of back pressure and poor heat transfer characteristics caused by slime, really works, as one Southern Power Station found out when they began using the W&T De-sliming Process. In just six months after W&T Chlorinators were installed, cleaning and excess steam costs were reduced from $1450 per month to $250 per month and a later survey showed an overall saving in excess steam costs of $16000 in a year.

Such savings are indicative of how your condensers may be made to operate more economically and with far less outage when W&T Engineers install chlorination to fight your slime problems.

To learn how chlorination may be profitably applied to your heat exchange equipment and to take advantage of W&T's 35 years' experience, write today.

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CHLORINE AND CHEMICAL CONTROL EQUIPMENT
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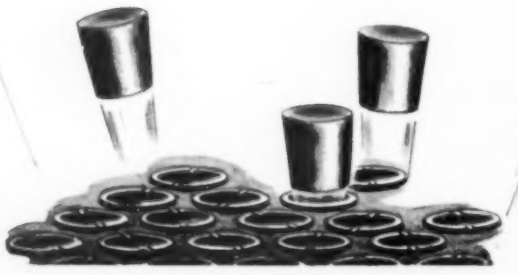

CD-31

Paris gets 215,000 more kw's; KELLOGG provides all critical power piping!

ALONG with the need for rebuilding and expanding Europe's industrial capacity, there is a corollary need for more efficient power production, calling for higher operating temperatures and pressures. As these conditions approach and exceed 1,000° F. and 1,700 p.s.i., piping naturally becomes a major problem, demanding the most modern techniques for satisfactory solution.

For example, piping layouts for the two new 100,000 KW main turbines now installed at Gennevilliers Station were first checked on Kellogg's exclusive apparatus for determination of stresses under operating conditions.

But correct design is only one part of the problem resulting from the demand for higher efficiencies. These critical conditions call for special alloys, requiring expert fabrication and installation . . . they necessitate the creation of special devices, such as bi-metallic transition pieces that, to date, have been made only by Kellogg. And they make the quality of on-the-site stress relieving and non-destructive inspection of alloy welding a prime consideration.

Kellogg has proven its power piping techniques in providing complete piping systems for high pressure and high temperature installations producing millions of kilowatts—of which more than 600,000 KW represents plants outside the United States. Currently, Kellogg is working on numerous power projects in Europe, South and Central America as well as in the U. S. Because of these widespread activities, Kellogg's experienced fabrication and installation crews are readily available to virtually any power producer throughout the world.

Special studies of unusual problems such as graphitization to assure long life and low maintenance.

Metallurgical research by recognized specialists who have made major contributions in this field.

KELLOGG

M. W. KELLOGG

Exclusive Equipment for accurately analyzing stresses in piping and providing unique data for critical installations.

Complete facilities for the fabrication of steel products from simple forgings to specially cast bi-metallic devices.

Top welding performance in shops and in the field by welders accustomed to working under X-Ray checks.

Quality control, devised by metallurgical experts, embracing forming, heat treating and non-destructive testing.

Vessels
Exchangers
Condensers
Process Piping
Forged and Welded Fittings
Radial Brick Chimneys*

★

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NEW EQUIPMENT NEWS

WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other information desired. For ease in making requests use the no-obligation, postage-paid card pages 35-36.

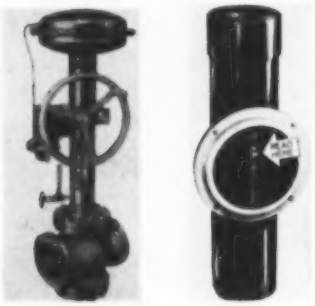
1—HANDWHEEL VALVE

Has handwheel built integral with superstructure of control valve

In this valve the continuously connected handwheel is powerful enough to operate control valve manually, company states, regardless of maximum instrument air pressure on diaphragm or in opposition to spring. Consequently this design, it is claimed, eliminates need for a bypass installation on valves 2 in. and larger.

Travel limit stops are incorporated which can be set to limit valve stroke from 0 to 100 per cent, according to company. An automatic position indicator is provided to show per cent of free travel of valve plug and in what portion of valve stroke the free travel can occur; also to show whether handwheel is in neutral position.

Use of worm gears is intended to permit mounting handwheel unit integral with steel spring barrel. Amount of power applied to valve stem is described as exactly the same at any point in valve stroke. Handwheel is designed to function whether valve is mounted horizontally or vertically and chain wheel mounting for remote operation is also possible. Window in superstructure is provided to permit servicing of packing box without disassembly. Handwheel may be applied to any of company's 1½ to 16 in. valves. Hammel-Dahl Co.



2—FLOW GAGE

Has short body, flanged or screwed pipe connections, fixed orifice

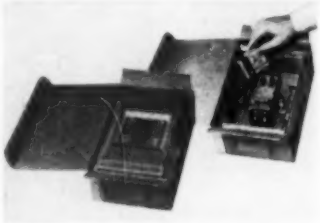
The recently redesigned Magna-Sight has a fixed orifice in the lower end. A tapered metering plug rises and falls with fluid flow rate in accordance with variable—area metering principles. The metering plug carries a permanent magnet, and a hollow, cylindrical, soft-iron follower rides on an external slot. Covering the slot is a plate with engraved scale calibrated either in gallons per minute or in millimeters. Position of follower relative to scale indicates flow rate.

Gage comes in brass, bronze, iron, steel and stainless steel 316; in sizes from ¾ to 4 in., and with maximum capacities from 3.5 to 250 gpm. Minimum capacity is 1/10 of selected maximum. Gage can be used for clear and opaque liquids, slurries, other fluids. Accuracy averages about 5 per cent over scale range, company states, and temperatures to 400 F, pressures to 500 psi can be accommodated. Fischer & Porter Co.

3—PACKAGING METHOD

For improved cartoning of basic units of multi-breaker load centers

Convenience in handling and stocking resulting from the packaging of basic components for quick selection is the reason for this new method, of packaging company's Type MO 8 multi-breaker load centers. Box and interior, covers (10 to a carton) and Ad-On breaker units are packaged separately.



The carton containing box and interior is designed to take components after selection is made for one complete package. By removing the filler of the basic carton, adding required Ad-Ons and inserting flush or surface cover in place of filler, one complete package is assembled which contains all components required. Square D Co.

4—MOTOR OPERATOR

Torsional output type; for outdoor air brake and disconnecting switches

The Type T motor operating mechanism drives the air switch by a single-phase d-c motor, operating through a gear reduction to give proper operating speed. Gear train uses a Micarta high-speed gear and chrome-plated hardened steel slow-speed gears. Output shaft is held from coasting at ends of its travel by a spring-operated, solenoid released brake said to require no periodic adjustment. Auxiliary switches are available for operation of indicating lamps, electrical interlocks, and relay circuits.

Gear train can be uncoupled to allow manual operation of air switch by removable operating handle. Mechanism can be recoupled to air switch only when both are in proper relation for normal operation, company explains. Mechanism is enclosed in sheet-steel housing. Cover can be lowered for manual operation or removed for maintenance. Comes in wide range of operating voltages. Westinghouse Electric Corp.

5—SHOCK ABSORBERS

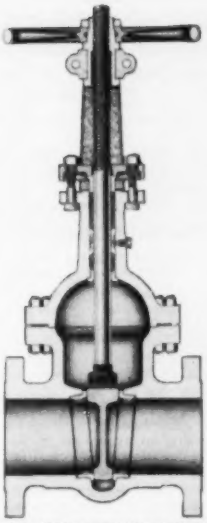
To prevent shock and hammering in pipe lines and liquid systems

With these shock absorbers hammering, leaky joints, opened pipe seams and excess pressure on valve packings can be reduced to a minimum, company reports, when such damage is caused by the quick closing of valves or any action that suddenly stops the flow of liquid through a pump or other apparatus. Company's Industrial, Dual and Super models are adaptable for general industrial use.

A rubber cushion, encased in a spherical metal chamber is provided to absorb the shock; there are no moving metal parts. The cushion pulsates con-

USE THE NO-OBLIGATION, POSTAGE-PAID CARD ON PAGES 35-36

For completeness of selection You can't beat the CRANE line



No. 33XR, 300-Pound Steel Gate for steam up to 850° F.; for water, oil, air or gas up to 500° F. Exelloy to Nickel Alloy seating. Sizes: 1½ to 24 in.

STEEL VALVES FOR SEVERE STEAM SERVICES

Crane Cast Steel Wedge Gate Valves find wide application wherever exceptionally rugged and durable steel valves are required. Body and bonnet have heavy metal sections and ample reinforcements at points under greatest stress. Straight-through ports assure minimum turbulence, erosion, and resistance to flow.

Solid wedge disc with close fitting disc guides maintains accurate seating on shoulder-type screwed-in body seat rings. "T-head" disc-stem connection prevents side strain on stem. Available in pressure classes from 150 to 1500 pounds with a variety of trim materials especially suited for recommended services. Screwed, flanged, or welding ends. See your new No. 49 Crane Catalog, p. 227.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
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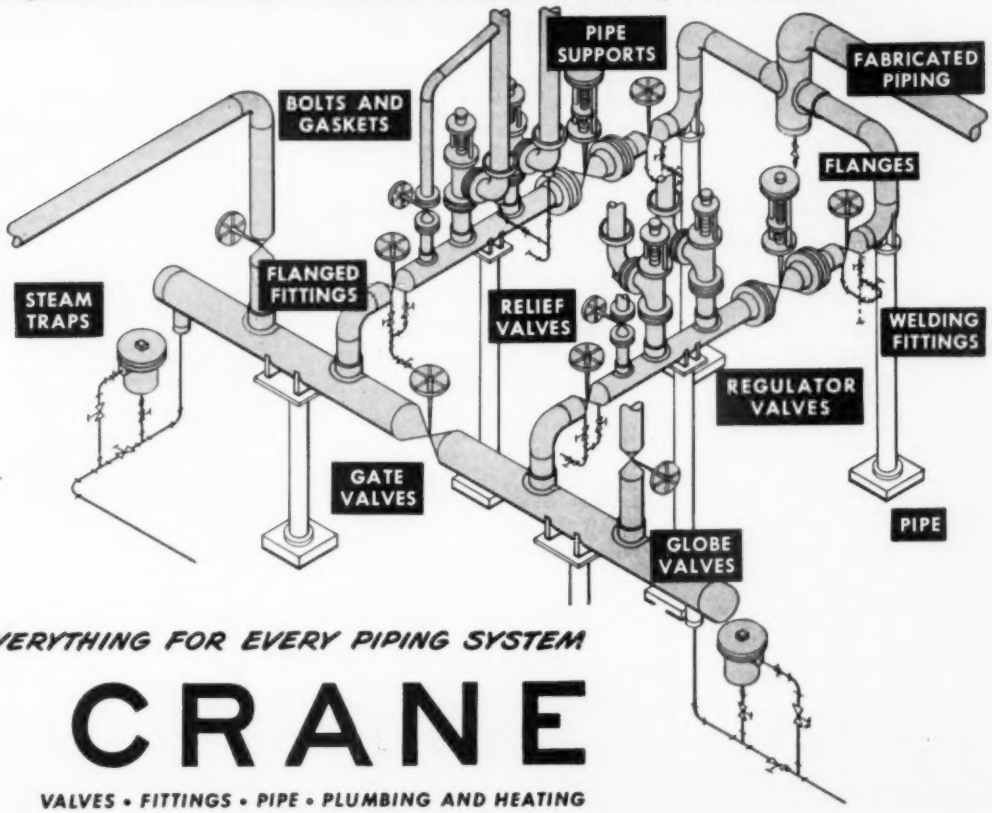


EVERYTHING FOR EVERY PIPING SYSTEM

CRANE

VALVES • FITTINGS • PIPE • PLUMBING AND HEATING

Mark the numbers of the items you wish to receive on the no-obligation, no postage card. Pages 35-36.

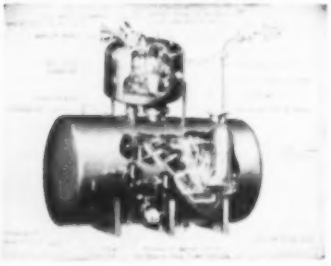
stantly according to increase or decrease of pressure in the system, manufacturer explains. Can be installed in any position. R-S Products Corp.

6—DEAERATING HEATER

For lowering the oxygen content of boiler feedwater, removing CO_2

This heater is designed to reduce oxygen in feedwater to less than 0.005 ml per liter (ASTM Referee or modified Winkler) regardless of rapid load variations or unusual operating conditions. CO_2 is also removed, company states, to protect boilers and accessories from corrosion and pitting.

In this heater, spring-loaded, self-adjusting spray valves in the first stage cause heating of incoming water to within 2 to 4 deg of the steam so as to remove most oxygen and free CO_2. In the second stage, the preheated water is mixed with a large excess of incoming



steam by scrubbing baffles, so most of the steam which remains as vapor carries with it small traces of undissolved gases on the way to the first stage where it heats the incoming water. Heaters come in sizes up to 2,000,000 lb per hour, and the second stage of each heater is made to fit individual plant conditions and storage capacities. Graver Water Conditioning Co.

7—ACIDITY TEST KIT

For on-the-job testing of transformer oil to prevent sludge deposits

According to company it takes only 2 min to run an acidity test with this kit. Contains 20 single measured doses of neutralizing KOH in sealed ampules, 2 pt of a neutral solution with color change indicator and 4 cylinders with corks. Ampules are made in 0.3, 0.6, and 1.5 (mg of KOH per gram of oil sample) values. Test is often made simply to show whether oil exceeds a certain ampule value, company points out. Kit is housed in mahogany case. Price complete is $25.00. Enough extra supplies for 100 tests are $13.00, and ampules may be ordered separately. The Gerin Corp.

8—CLAMP KIT

Is "try-it-for-size" assortment of 11 standard neg ator clamps

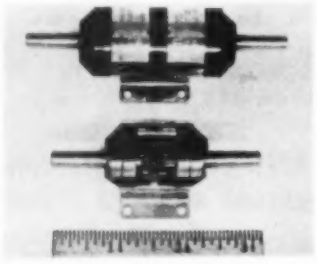
The assortment in NC-11 Kit includes one each of standard sizes, with clamping pressures from 5 oz to 18 lb, automatic take-up (and constant pressure)

out to maximum openings of $3\frac{1}{4}$ to 20 in., widths from $\frac{1}{4}$ to $1\frac{1}{4}$ in., and coil diameters from 5/16 to 2 in. Hunter Spring Co.

9—SMALL SPEED CHANGERS

Have precision hobbed gears of 96 pitch for smoother operation

The 96-pitch gears now available in these miniature speed changers are intended to provide smoother operation, better angular precision and about half



the backlash obtainable with 48-pitch extruded gears. In single or multiple sections and with more than 500 different ratios, these units are recommended for instruments, controls, recorders, regulators and similar applications where low-power gearing is required.

Weight and dimensions are same as standard units; prices 15 per cent extra. They are tentatively rated at 1/50th hp, speeds up to 20,000 rpm on high speed shaft; and torques up to $1\frac{1}{2}$ lb-in. on low speed shaft are said to be practical. Metron Instrument Co.

10—VINYL RESIN COATING

For wet or dry service over operating temperatures of -40 to 160 F

This coating is described as resistant to alkalies and mineral acids; as insoluble in alcohols, greases, oils, and aliphatic hydrocarbons, and as having low permeability to water vapor and low water absorption. It is recommended for applications where metal is subject to deterioration from chemical or moisture attack. An applied film of this material is non-flammable and imparts neither taste, odor or toxicity, company states.

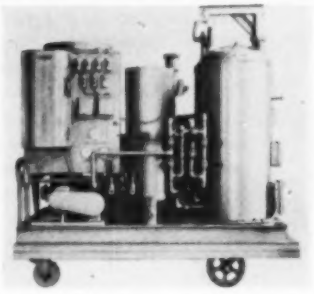
The coating is claimed to be an improvement over previously available materials of a similar base in that it develops good adhesion to relatively smooth surfaces without heat curing. It air dries rapidly so equipment may be placed in service an hour after coating, according to company, and the resulting surface is tough and durable. Comes in clear, black or gray high-gloss finish. Other colors may be formulated. For application by brush or spray at coverage of 400 sq ft per gal. The Dampney Co. of America.

11—PURIFICATION SYSTEM

For insulating oils, is designed for fully automatic operation

The newly designed Purivac system is reported to eliminate acidity, moisture and sludge and to completely restore dielectric strength, all in one operation; also to reduce deterioration of fabric insulation, prevent excessive build-up of core moisture and to prolong life of insulating oil indefinitely.

The system consists of company's

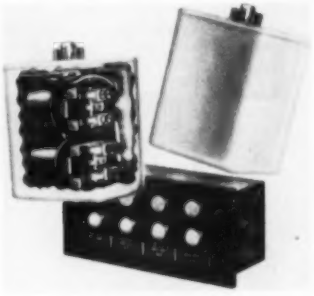


dual purifiers, heat exchanger, dehydrating and degasifying unit, electrical control panel, pumps and motors. Entire assembly is mounted on dolly for ready handling. Purification, dehydration and degasification cycles are thermostatically controlled, company points out, and dual purification units may be operated separately, in series or in parallel. Purification operations may be carried out in the field or at central station while transformer is in service. Honan-Crane Corp.

12—ALARM SIGNAL SYSTEM

Is designed for use in hazardous locations and corrosive atmospheres

Series 400 alarm signal units are hermetically sealed relays on a sealed plug-in octal socket. System conforms with National Electric 1947 Code specifications for Class I, Div. 2 installations.



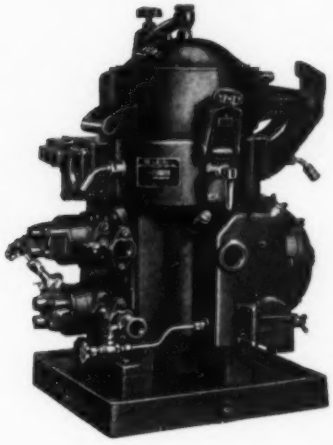
Many combinations of light and sound signals are available to warn of abnormal operating conditions. System can be used for monitoring speeds, time cycles, pressures, temperatures, liquid or gas flow, or electrical or mechanical equipment operation. Panalarm Products, Inc.

13—SPRAY FAN COOLERS

For low-ceilinged refrigerated rooms where high capacity is required

In this "low head room" design the fan section is located on the side of the unit. Air enters the spray section at the top; it is chilled in passing down through

I KEEP OUT DIRT and WATER



"I am De Laval Centrifugal Force. When I am put to work to purify lubricating oil — either turbine lube or Diesel lube — I do more than just remove the ***dirt*** present in the oil. I take out ***water***, too!"

That's where De Laval Centrifugal Force differs from other means of maintaining lubricating oil. It does its job ***completely***—the protection it affords against trouble from impurities remaining in lubricating oil is ***complete*** protection. No half-way measures for De Laval Centrifugal Force — the water is discharged continuously after being centrifuged out, and the dirt is stored outside of the zone where purification takes place.

De Laval Oil Purifiers have another advantage — enough reserve capacity to take care of a sudden emergency, such as a surge of water due to a leak.

Write for additional information.

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

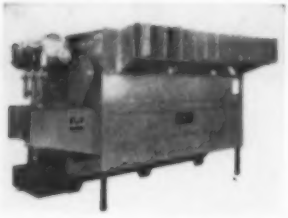
DE LAVAL

OIL PURIFIERS

for more dependable power production

Mark the numbers of the items you wish to receive on the no-obligation, no postage card. Pages 35-36.

the spray and over the refrigerant coils; it enters the fan section at the bottom and is discharged from the side at the top. When refrigerant temperatures below freezing are used, the process is kept free from frost, ice, or from freezing by the use of brine or company's No Frost Liquid in the sprays.



Five unit sizes are now produced with capacities ranging from 1680 to 11,000 cfm of chilled air. The maximum height is 72 in. Floor space required ranges from 16 sq ft to 72 sq ft. Because of improved efficiency in air travel credited to it, this new type cooler is said to promote increased air delivery at lower power consumption. Niagara Blower Co.

14—FACEPIECE

For welding operations in atmospheres containing toxic vapors, dusts

This device is designed to combine in one unit protection against ultra-violet and infra-red radiation, impact and pitting, and inhalation of toxic fumes. It consists of an air-tight rubber mask

and chrome leather hood with flexible breathing tube connections. The aluminum frame and flip-front assembly hold a sealed-in safety lens, and removable welding and pitting lenses. Different shades of filtering lenses can be used. The flip front is provided to let wearer examine work without interfering with respiratory protection.

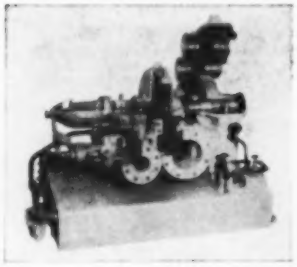
Facepiece is built to afford increased lateral and vertical angles of visibility. It weighs 8 oz more than standard welding shields, but this weight is said to be distributed through face and head supports. When connected to an approved air line, the incoming air stream enters mask at chin level and flows over lens window to avoid fogging, company explains, and two spent air outlets at jaw level direct air stream around interior of hood.

Facepiece is adaptable to three types of masks: combination fresh air hose; airline respirator, and all service canister. Parts may be obtained for conversion of company's abrasive mask facepiece. Mine Safety Appliances Co.

15—STEAM TURBINES

With close-coupled, integral reduction gears for low speed uses

Fans, pumps, compressors and generators can be driven at proper speeds by Gearturbines while the turbines operate at their most efficient speed, manufacturer states. They combine a rugged, compact speed reduction mechanism solidly coupled to company's Type E turbine and are designed to operate as single unit. Three machined feet provide a three-point support. Single helical gears with low helix angle are used to give low thrust against bearings. Endwise movement of one shaft doesn't affect axial location



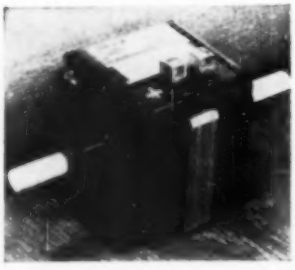
of the other, it is explained, and thrust isn't transferred from gears to turbine. Gear-turbines have standard gear reduction ratios.

Turbine and gear are factory aligned on a heavy plate steel base which also serves as oil tank. Additional steel members are provided to maintain rigidity and resist torsional distortion. Unit is shipped completely assembled. Westinghouse Electric Corp.

16—CURRENT TRANSFORMERS

For low-voltage metering indoors with or without thermal demand meters

Type MR through-type transformers are described as having high accuracy with ASA class 0.3 at burden B-0.1 and a continuous current rating of 200 per cent while not exceeding a temperature rise of 55 deg C. Accuracy is said to be maintained over current span so only two current transformers—200 and 400 amp ratings—are required to meter in



complete range from 10 to 800 amp. Grain-oriented Hipersil is used in core to reduce weight and dimensions.

Transformer is mounted in metal case with Moldarta cover and removable, silver-plated primary conductor. Secondary terminals are mounted on phosphor bronze supports and have solderless connectors for No. 6 to No. 14 conductor. No short-circuiting device is used, company points out, because open-circuit voltage under full load is only approximately 100 v. Transformers are designed for mounting in any position in meter box or on switchboard. For operation up to 600 v with primary circuit ratings of 200 or 400 amp to 5 amp. A three-wire transformer is available with ratio of 200-200 to 5 amp. Westinghouse Electric Corp.

17—CONCENTRIC DIAL INDICATOR

Is designed for transmitting, receiving and controlling instruments

The dial construction of this indicator is intended to make instrument mechanism easily accessible for inspection or adjustment by simple rotation of the dial. A large pointer with 270 deg sweep, together with white numerals on black background are said to be legible from 50 to 100 ft. The instrument may be used with only low pressure unit or mercury manometer actuation for differential or absolute pressure applications.

Available as simple indicator, indi-

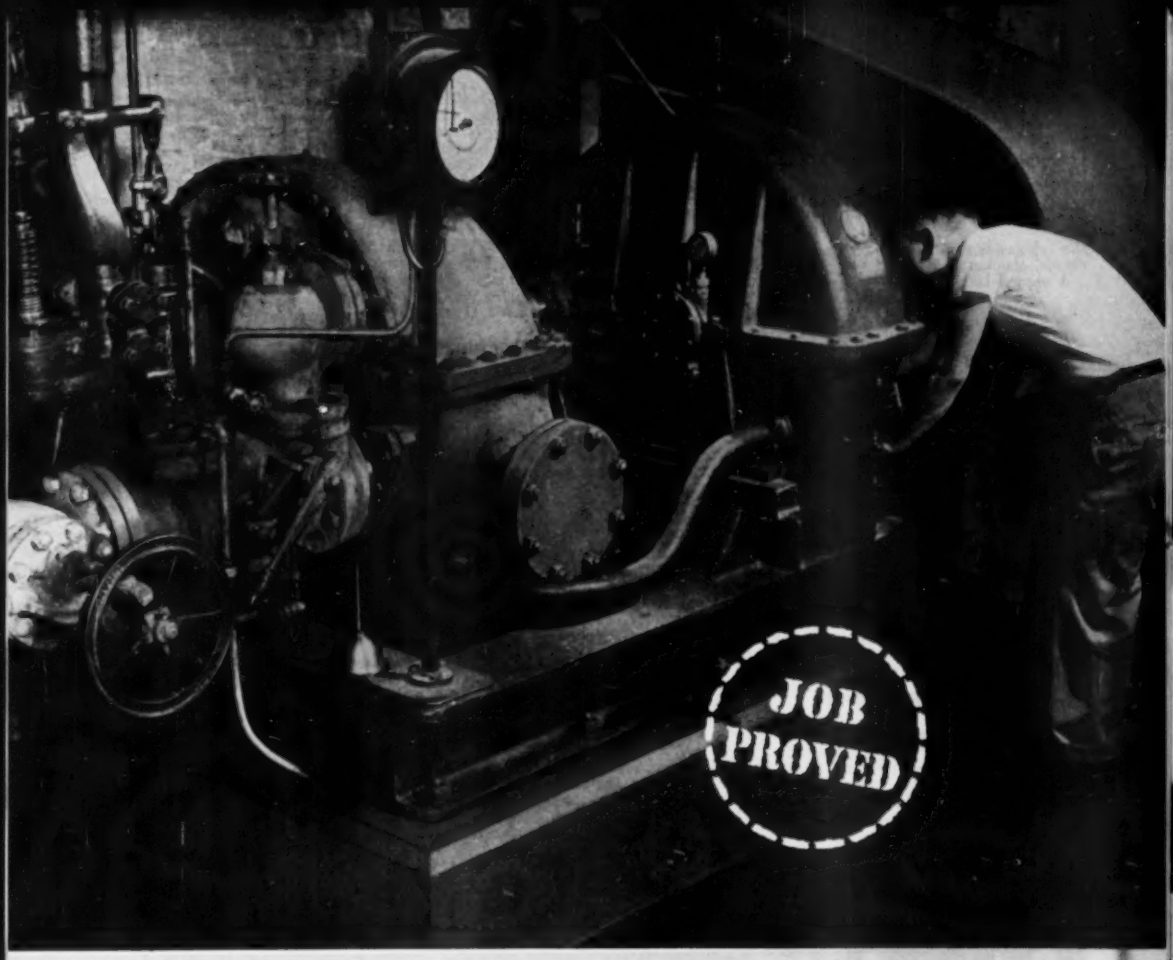
cating receiver, indicating controller or indicating receiving controller. Standard ranges are 0 to 10 on square root scale and 0 to 100 and 0 to 200 on uniform scale. Taylor Instrument Companies.

18—AUTOMATIC DEGASSER

For use in conductivity measurements to determine steam purity

This device is engineered to produce continuously and automatically an approximate 50-50 split of a flowing steam sample—one fraction containing any dissolved solids that may be present, and the other any dissolved gases. The sample containing the solids is run through a cell in which its electrical conductivity is measured to provide an indication of steam purity.

Flowing steam and condensate contact only stainless steel in this unit, it is pointed out, so contaminating materials are not picked up. Time interval from flow cell is about 1 min. This means that operator can correlate recorder charts made in conjunction with



SUNVIS 900 OILS REDUCE COSTS 25%

Papermaker Gets Maximum Equipment Protection, Extra Long Service, from Superior Turbine Lubricants

In a large paper mill, eight steam turbines drive paper machines and pumps, and generate power for ventilating equipment. Ten years ago the mill began lubricating these turbines with a "Job Proved" Sun oil. They gave unfailing service with remarkably low oil and maintenance costs.

Four years ago, when Sunvis "900" Oils first became available, the Sun representative serving the mill saw an opportunity to effect even greater economy. He suggested that the medium-priced Sun oils in use be replaced by the more costly Sunvis "900" Oils. He knew that these modern, fortified lubricants—*more costly* on a per-gallon basis—would prove *less costly* through the years because of their remarkably long life. His suggestion was followed.

The Sunvis "900" Oils have fully justified this confidence, saving the mill 25% or more on lubrication costs. Furthermore, the papermaker knows his equipment—running or idle—is fully protected from rust and corrosion.

Sunvis "900" Oils are *good for the life of your production equipment*. Coupled with the know-how of the Sun representative who calls on you, they are good for your pocketbook, too. For more information, send for a copy of the illustrated booklet "Sunvis '900' Oils". Write Department PN-3.

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"JOB PROVED" IN EVERY INDUSTRY

SUNOCO

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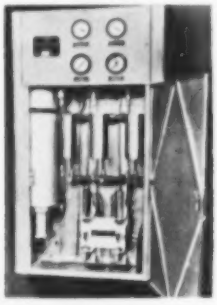
the degasser with other operating charts, company explains.

A second cell is provided to measure

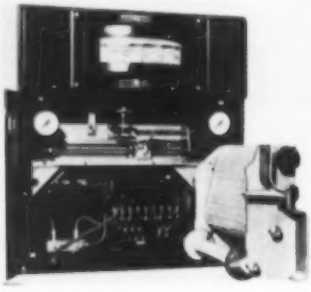


conductivity of the gas fraction. Both fractions can be diverted for chemical analysis. Hagan Corp.

19—STRIP CHART RECORDER

Is air operated; used in indicating, controlling, recording instruments

With the Pneumatic Capacilog, temperatures, speed, flow, pressure, static grain loads, a-c and d-c volts, amperes can be measured easily, it is stated. The control function is performed by



the floating power of air—via company's Electronic Link—operating diaphragm motors connected to valves, dampers, levers and pistons. Instrument is self-contained, has only two external air connections. Wheelco Instruments Co.

20—SELF DRAINING BLENDER

For introduction of chemicals to "wet" water at point of use

The Hydroblender, made of brass castings and fittings and a tube of lucite, weighs approximately 35 lb. It can be mounted on wall machine or column. Chemicals are placed in the lucite tube in the form of water-soluble capsules, company explains, and these dissolve in proportion to the water passing through a built-in venturi nozzle. When used with company's Aquadyne capsule which weighs 3 lb the resulting solution has a surface tension of 30 dynes. Each Aquadyne capsule makes 1000 gal "wet water" (reduces surface tension from 72 to 30 dynes). The Hydroblender holds two capsules.

Principal applications of the Hydroblender are in industrial dust control, blending, mixing and washing. Pressures up to 100 psi can be handled by Hydroblender, company reports. It operates at any water pressure from 25 lb up, but most efficient spraying pressure is between 60 and 75 psi. When water supply is above 100 psi a pressure reducer is recommended, and when less than 25 psi, a booster pump should be used. Aquadyne Corp.

21—VERSENE TEST KIT

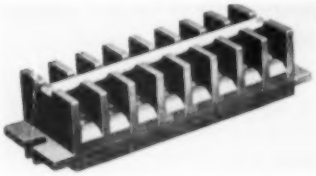
For quick determination of water hardness by color indication

With this new Versene water hardness testing kit you can determine the hardness of your own boiler water, process water, or tap water easily and quickly—in less than two minutes. The test is simple to make and anyone who can tell red from blue can make it and be accurate to within one grain of hardness per gallon. The set consists of three vials of chemicals and a small test tube contained in a handy, sturdy, pocket size plastic box. There is enough to make 50 separate tests, depending on the water hardness. It is furnished with complete instructions and refills are available. To make the test all that is necessary is to fill the test tube with a sample of water, add 3 drops each of solutions 1 and 2, and then adding solution 3, drop by drop, until the color of the sample changes from red to blue. The number of drops of solution 3 necessary to change the color is the hardness of the water in grains per gallon. The complete test set sells for $3.00 postpaid. Bersworth Chemical Co.

22—ELECTRIC TERMINAL BLOCK

Is designed to provide for unlimited number of circuit terminations

Simplified assembly procedure of the Add-A-Point is intended to permit addition of points at any time after installation. Marking strips and covers may be attached. Rated at 60 amp these terminal blocks can be operated safely up to 750 v, company points out, and they are suited for junction box, steel panel, machine tool and switchboard mounting. A complete block consists



of required number of terminal points, an end piece, marking strip, and cover, if desired.

Block is also available in yellow, blue, red and green for color coding purposes. Terminal strips may be had with solderless connections. The Wama Co.

23—CAR SHAKER

For unloading loose materials from open hopper-bottom type cars

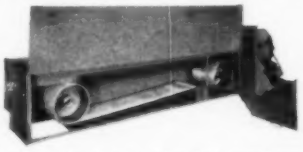
The Lo-Hed Car Shaker is offered in combination with a 5-t twin hook hoist and controls, or with a single hook 5-t hoist and controls, or separately for use with existing hoisting equipment. According to company, this shaker makes emptying cars possible for one man to handle in a matter of minutes. It is said to afford a fast, easy way to unload coal, sand, coke, slag, limestone and similar materials.

Interlocking controls are provided for increased safety with the motorized trolley hoists furnished with a Lo-Hed Car Shaker combination. In this arrangement the hoist has a slack-line switch. Shaker cannot be operated until it is in position, company explains, and motor trolley cannot be started when shaker is in operation. American Engineering Co.

24—BELT FEEDER

Is enclosed, but accessible, for installation in tight places

Originally designed to deliver a continuous stream of material from an intermittently discharging automatic bulk scale, this unit also has applications as feeder or "take-away" conveyor. A variable speed drive can be furnished to vary the stream in conformity with timed discharges of auto-



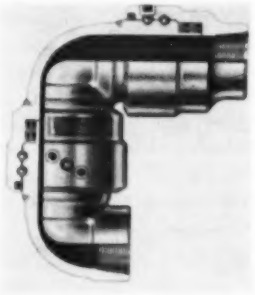
matic scale above. Also has cantilever pulleys for endless belting, removable skirt plates.

Comes in lengths of 18 to 60 in. and in stream widths of 2, 4 and 6 in. with rated capacity up to 1500 cu ft per hour. Belt can be driven by single speed motor at either end, from line shaft, or variable speed drive, Manual control, or special remote control is also available. Richardson Scale Co.

25—SWIVEL PIPE COUPLING

For conveying fluids under high pressure through pipe that rotates

According to manufacturer, the All-Flex Ball Bearing Swivel Pipe Coupling has rotating members held tightly together with two sets of ball bearings operating in flame-hardened and ground ball races. Coupling is designed for average speed of rotation not to exceed 60 rpm. It is described as having a metal backed packer assembly



which renders unit pressure tight, sealing all pressures from vacuum to 12,000 psi. Full pressure range is said to be automatically covered without manual adjustment of packing.

High pressure swivel pipe couplings

PRIMING OR FOAMING?

Carryover is a tough problem that you can't argue, or guess, out of existence. It can cause serious mechanical, operating and processing difficulties, ranging from damage to process materials to deposits on high pressure turbine blades. To know the cure, you *must* first know the cause. The chief causes of carryover are priming and foaming.

Priming, the *mechanical* entrainment of boiler water in steam, is caused by "belching" or surging. Its correction usually involves *mechanical* considerations, such as operating and design modification.

Foaming, the entrainment of boiler water in steam, is caused by build-up of foam. It results from high alkalinity, high dissolved and suspended solids, oil contamination, etc. Correction of foaming usually involves *chemical* considerations, such as proper control, anti-foam treatments, etc.

The Drew System of Water Treatment eliminates guesswork! It starts with proper diagnosis. It includes recommendations for corrective treatment and other preventive measures, such as modification of operating cycles and redesign of equipment, if required. It is specialized service applied to your individual boiler problem.

Don't gamble with guesses! Consult the Drew Engineer or write for further information on carryover and other water problems.

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are made of steel, and available in a wide range of sizes and for working temperatures up to 225 F. Gil-Lair Products, Inc.

26—EXPANSION JOINTS

For axial, offset, radial motion control in high pressure systems

CMH Flexoniflex Joints are for the 1000 psi range and recommended for use wherever gases or fluids must be conveyed under high pressure and between relatively movable parts. They consist of corrugated, bellows-type sections of stainless steel or other alloys formed within integral control rings and end sections.

Standard units are made with single or multiple plies and may be lined or unlined according to application. Sizes begin at ⅝ in. ID and continue through range of extra high pressure pipe sizes. Temperature range is from sub-zero to 1400 F for stainless steel, and upward limit can be extended with use of special alloys. Working pressures of 1000 are set as base standard, company states, but all designs are engineered to permit safety factor as required by service. Units for absorbing radial and offset motion, as well as axial motion, are engineered from basic design. Chicago Metal Hose Corp.

27—STEEL STOP VALVES

For steam, oil or gas lines; for 600 lb at 900 F, 1500 lb at 850 F

These forged steel stop valves can be installed in almost any service where small steel globe or angle valves are used, manufacturer states. They have swing bolted packing glands and large packing chambers to facilitate repacking, and are made with bronze yoke bushings to prevent galling or freezing of steam. Parts are interchangeable.

Valves are available with bolted or union bonnets in sizes ¼ through 2 in., and with screwed or socket welding ends. Built of carbon or chromium molybdenum steel for two ranges of service conditions. Available for shipment from stock in most sizes. Edward Valves, Inc.

POWER PLANT *Construction News*

Jasper, Ala.—Alabama Power Co., Birmingham, Ala., has authorized plans for expansion in Gorgas No. 2 steam-electric generating plant near Jasper, Walker County, with installation of turbine-generators with rating of 100,000-kw, high-pressure boilers and auxiliary equipment. Cost reported over $7,500,000, with transmission lines and other operating facilities.

Los Angeles, Calif.—Board of Regents, University of California, 405 Hilgard Ave., West Los Angeles, has authorized plans for new boiler plant for central-heating service at institution. Estimates of cost will be prepared soon. Spencer & Landon, 1724 Hillcrest Ave., Los Angeles, are architects.

San Francisco, Calif.—U. S. Public Buildings Service, 1729 New York Ave., N.W., Washington, D. C., has plans nearing completion for new boiler house and stack, for central-heating service at Marine Hospital, 14th and Lake Sts., San Francisco. Work will be carried out in connection with an expansion program at institution, entire project to cost about $3,500,000. Douglas D. Stone and Lou Mulloy, 619 California St., San Francisco, are architects.

Loveland, Colo.—Bureau of Reclamation, Denver Federal Center, Denver, Colo., plans call for bids in June for construction of Pole Hill power plant, vicinity of Loveland, with installation of one 36,000-kva. turbine-generator and auxiliary equipment, Colorado-Big Thompson project.

Wilmington, Del.—Delaware Power & Light Co., Wilmington, has authorized a 1950 expansion and improvement program in plants and system to cost about $25,000,000. Close to $12,500,000 of fund will be used for work on new Edge Moor steam-electric generating station, previously noted in these columns, scheduled for completion in 1951.

Miami, Fla.—Florida Power & Light Co., Miami, has authorized an expansion and improvement program in plants and system during 1950 to cost about $18,000,000, of which approximately $5,500,000, will be used for extensions in power plants and increased generating facilities.

Atlanta, Ga.—Georgia Power Co., Atlanta, will expend about $34,000,000 for expansion in plants and system during 1950, of which about $15,000,000 will be used for increase in generating facilities. Work will include construction of new Yates generating station on Chattahoochee River, near Newnan, Ga., with turbine-generators, high-pressure boilers and auxiliaries for capacity of 200,000-kw; addition to Bartlett's Ferry hydroelectric generating plant on same river, vicinity of Columbus, Ga.; and extensions in Furman Shoals hydroelectric power plant on Oconee River, near Milledgeville, Ga.

Sioux Center, Iowa—Town Council plans extensions and improvements in municipal power plant, with installation of equipment for increased capacity. Details and estimates of cost will be determined at early date. Buell & Winter Engineering Co., Insurance Exchange Bldg., Sioux City, Iowa, is consulting engineer.

Louisville, Ky.—Louisville Gas & Electric Co., Louisville, has arranged financing in amount of $41,000,000, proceeds to be used in connection with 1950 expansion and improvement program in plants and system, including increase in generating stations for larger output.

Vienna, Md.—Eastern Shore Public Service Co., Salisbury, Md., will expend approximately $3,600,000 for expansion in steam-electric generating station at Vienna during 1950, with installation of new generating unit and auxiliary equipment for increased capacity. This is part of extension and improvement program for year.

Cambridge, Mass.—New England Power Co., Cambridge, is arranging financing in amount of $7,800,000, portion of proceeds to be used for extensions and improvements in power plant and system for increased capacity. This will be part of 1950 expansion program.

Barnesville, Minn.—Town Council has plans under way for new municipal power plant, using Diesel engine-generating units and auxiliary equipment. Fund of $178,600 has been authorized for project and bond issue is being arranged. It is understood that work will be carried out in spring.

Boulder City, Nev.—Bureau of Reclamation, Denver Federal Center, Denver, Colo., plans call for bids in June for extensions in Hoover power plant, with installation of two hydraulic turbines of 115,000-hp. rating and one such turbine of 70,000-hp. capacity, to be used in connection with two 82,500-kva. and one 62,500-kva. generators, and complete auxiliary equipment, Boulder Canyon Project, Arizona-California-Nevada.

Brooklyn, N. Y.—Board of Education, 49 Flatbush Ave. Extension, plans central-heating plant in new three-story junior high school on Halsey St. Entire project will cost about $2,725,000. Bids for erection are expected to be asked soon. John Muller, 41 Union Sq., New York, N. Y., is architect.

Raleigh, N. C.—Carolina Power & Light Co., Raleigh, has authorized fund of approximately $18,000,000 for expansion and improvements in plants and system during 1950, including completion of extensions in steam-electric generating station at Lumberton, N. C., with installation of new 60,000-kw. turbine-generator and auxiliary equipment.

Carrington, N. D.—Central Power Electric Cooperative, Inc., Carrington, has preliminary plans under way for new

(Continued on page 106)

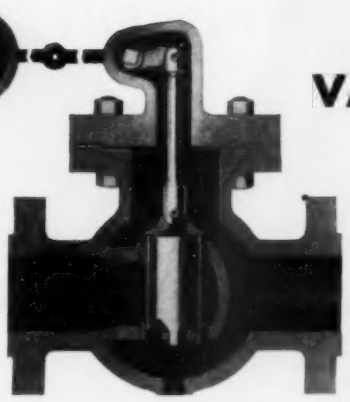
COPES BALANCED VALVES

Wherever you use float valves, avoid losing any of your operating force in the stuffing box. Insist on low and constant valve stem friction.

Make sure of instant, accurate response to your actuating force—no matter what your flows and pressures—by demanding close control of the unbalanced forces found in every valve.

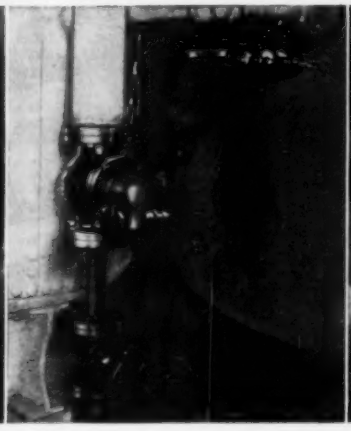
Provide for minimum pressure losses at high flows by requiring your valve ports to be accurately designed for the conditions you specify.

In other words—insist on COPES Balanced Valves. They offer all these important advantages—plus long service life with minimum maintenance. Write in detail about your needs.



With the COPES Type BI Valve, rotating stem means low stuffing box friction. Accurate balance assures quick and accurate response. Exact capacity you need is provided.

Float-operated COPES Type BI Valve controls flow of condensate from flash tank to storage tank.



Flow of blow-down water from a flash tank is controlled by this float-operated COPES Valve.

Water level in a deaerating heater is controlled by this float-operated COPES Balanced Valve.

NORTHERN EQUIPMENT COMPANY
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Bulletin 443-B gives condensed data on all major COPES products. Write for a copy—your letterhead, please. Keep it for reference.

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NOW! AT NO INCREASE IN COST TO YOU

Makes a good steam trap better

Nearly 650,000 Yarway Impulse Steam Traps have already been installed—proof that they are doing a good job.

Now a *stainless steel* body makes this famous little trap even *better—at no increase in cost.*

Better in *wear*, better in *service*. Users will find Yarways require less maintenance than ever. All parts are wear-resistant, practically wear-proof. There is only one moving part, a small, stainless steel, heat-treated valve. Important, too—Yarway Impulse Traps are *suitable for all pressures up to specified maximum without change of valve or seat.*

Other popular advantages are *small size, light weight, easy installation* and *low cost.* Often it costs *less* to buy a new Yarway trap than to repair an old, ordinary trap.

In performance—ask any user. They all say Yarways are the traps that *get equipment hotter sooner and keep it hot!*

For better steam trap performance, try *new* stainless steel Yarways.

YARWAY IMPULSE STEAM TRAPS ARE SOLD BY OVER 200 DISTRIBUTORS. THERE IS ONE NEAR YOU.

Write for name and address.

YARNALL-WARING COMPANY
114 Mermaid Avenue, Philadelphia 18, Pa.

YARWAY IMPULSE STEAM TRAP

LETTERS TO THE EDITORS

THEY FIX THE BIG STUFF

UNDER THAT TITLE, some very fine maintenance photographs taken in The Detroit Edison Co's. plants, were published in the October 1949 issue of POWER GENERATION. But I am greatly surprised that so safety-minded and progressive an organization as The Detroit Edison Co. would permit men to work in the furnace of a slagged-up water-tube boiler without wearing "hard" hats, especially since it is stated that "five stories up in the superheater tubes, others were making careful inspections," from where even a small piece of loosened clinker or slag would make a rather large hole in the head of at least one of these men.

It is also surprising that the men who are deslagging the tubes would be striking a chisel bar with a sledge hammer, while the foreman is looking on, without wearing their protective goggles.

It also looks as if Foreman Al Lindberg has chosen a rather precarious perch on the round top of the turbine cover from which to give crane signals. A little oil under his feet or a slight rais-step, and Al would probably find it is a long way to the floor. Besides, mechanics' work shoes, even foremen's, don't do the turbine casing finish any good.

This series of pictures is most interesting to one so much concerned with the maintenance of "the big stuff" as myself, particularly since they show how the other fellows do it. But I would expect to be tarred and feathered if any of my men met with an accident under the conditions indicated.

Jersey City, N. J. GEORGE E. LYONS

We had wondered about those points, too, but it occurred to us that, if the pictures had been posed especially for the photographer, the hard hats would have shadowed the faces and he would have asked for them to be taken off. And some of the positions of the men would have to be changed to get a good shot. We have tried to get pictures like this with our own cameras and know some of the photographer's problems.

We have personally observed, over a good many years, the high operating standards and outstanding safety record of this utility company and we knew there was an explanation of these points.

Sure enough, when we asked DE about this, the following reply came from Mr. Porter.

The original thought behind these pictures was to recognize on a Company-wide basis the good record of the power plant maintenance groups in keeping equipment in service during the recent high peak load periods. Most of the pictures taken were posed for the *Synchroscope*, a Company magazine, and did not represent actual working conditions. They were never originally intended for publication outside the Company.

The picture inside the furnace of No. 10 boiler at Delray was taken after all boiler and superheater tubes above had been thoroughly cleaned of slag and sandblasted. The canvas lying on the screen tubes was for catching the sand. The man with the sledge hammer was merely loosening the tuyeres and the camera angle makes these men appear much closer together than they really are.

We do not know why Foreman Al Lindberg stood on the round top of the turbine cover. In the first place, signals are usually given to the crane operator from the floor; and, second, they are not given by the foreman but by the rigger. It all looks like something dreamed up for the photographer.

We would like to emphasize that we have a very active and wide-awake safety organization, not only throughout our Company but also in our own department. Safety tools and safety equipment are fully provided. Boiler repairmen are furnished hard hats and safety goggles. Where necessary, prescription goggles are also furnished.

If you will refer to the safety records kept by the American Standards Association and the National Safety Council, you will note how our Company safety record compares with those of other similar electric utilities during the past several years.

Detroit, Mich. G. A. PORTER
Chief Engineer of Power Plants
The Detroit Edison Co.

BOILER FEED PUMP OPERATION

THE ARTICLE on this subject by I. J. Karassik, in the November issue, is of interest in pointing out ingenuous ways of handling irregular conditions in the particular type plant chosen.

His hypothetical plant of the twin-unit type is with the "minimum reserve" margin and represents less protection than some engineers are willing to accept. One boiler feed pump per unit backed up by another pump with divided responsibility as reserve rather over-simplifies the problem.

With a similar unit system using two active pumps on each, it becomes advantageous to provide for control of division of load to avoid trouble when this load backs down to a little more than one-half capacity on each pump. This is critical, because of variations of maintenance conditions within individual pumps. (Increased running clearances tend to lower the no-load pressure—i.e., put a "hook" in the characteristic curve.)

With hand control of these pumps the process of getting a main unit off or on, with another running, is a tricky job. This is so partly because of the need to avoid aerated water; partly because of the possibility of mixing steam and cool water where a destructive water hammer could start; partly because of the obvious sudden extreme temperature changes during the transition; and finally due to these special valve moves coming coincident with many other specific items that must have the attention of the operating personnel during load dropping and pick-up periods.

Unless very special conditions dictate otherwise, this writer favors pressure-flow controls on the various boiler feed pumps, both for single and multiple pumps per unit. Each deaerator should be served by a pump or group of pumps with controls arranged for each pump or group to deliver a quantity of water proportionate to the throttle flow of the corresponding turbine. This will permit keeping the deaerators each in service all the time the main unit is in, and will offset various possible irregularities among the various pumps.

With such controls for regular operation, the processes suggested by Mr. Karassik become the natural ways and means of operation on failure of control equipment.

If a common pump is used as a spare, it should have quick acting suction valves so that no appreciable delay is experienced in putting it in full service, particularly if it backs up a single main pump.

Hazleton, Penna. C. W. BELL, SR.
Engineering Consultant

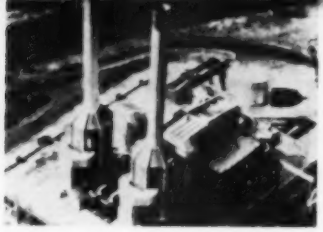
Karassick Replies

MR. BELL'S comments are very well taken, particularly in view of the fact that the author's article could have been misinterpreted to imply that he favors the arrangement described. Such is not quite the case, however, as the author agrees fully with Mr. Bell as to the advisability of throttling controls which would serve to provide flow from the feed pumps proportionate to the throttle flow of the corresponding turbine.

The article dealt, however, with typical installations which exist already and which — in several instances known to the author — have led to operational problems. The article, therefore, was intended to explain to the operating personnel the origin of these difficulties and

(Continued on page 79)

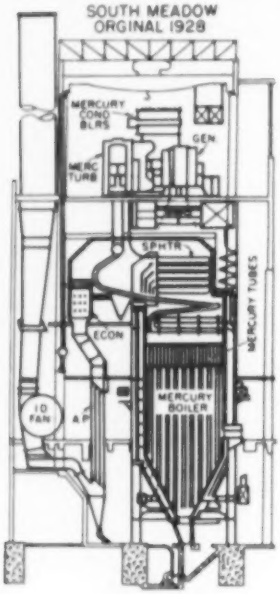
SOUTH MEADOW contained original 1928 unit, now replaced by 1949 unit



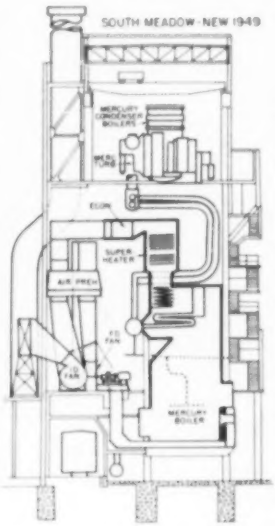
SCHENECTADY

The Mercury Power Plant From South

South Meadow Station, Hartford Electric Light Co. 1928 Mercury turbine generator, 10,000 kw, plus 124,000 lb per hr of 400 psi 700-F steam



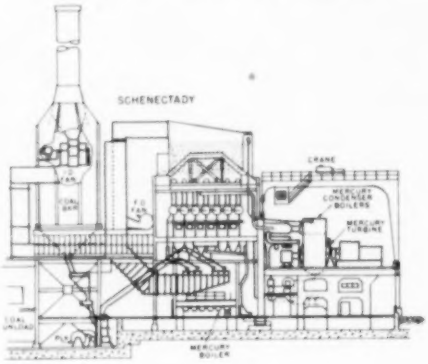
Principal features of the new 1949 mercury power plant installation replacing the original 1928 unit at South Meadow Station, Hartford Electric Light Co. Mercury turbine generator, 15,000 kw, plus 210,000 lb per hr of 400-psi, 700-F steam



SUMMARIZED on these two pages is the development of the mercury power plant in the United States, from the initial installation at South Meadow Station in 1928 to the latest, Schiller Station, in 1949. On the following pages, you will find details of the mercury cycle, the original and new units at South Meadow and the new Schiller Station.

Note:—These cross-sections are not to same scale.

Principal features of the mercury power plant installed at Schenectady Works, General Electric Co. Semi-outdoor station; mercury turbine-generator, 20,000 kw plus 325,000 lb per hr of 400-psi, 750-F process steam



Design and Operating Data for Mercury Power Plants, as of January 1, 1950

Item No.		Hartford Electric Light Co., So. Meadow Station 10,000 Kw Original Unit		15,000 Kw New Unit		General Electric Co., Schenectady Works Mercury-Steam Station	
	GENERAL PLANT DATA:						
1	Date placed in operation	1928		1949		1933	
2	Location of Mercury Plant	Hartford, Conn.		Hartford, Conn.		Schenectady, N. Y.	
3	Type of service	Topping Existing Steam Generating Station.		Topping Existing Steam Generating Station.		Topping Existing Steam Generating and Process Steam Plant.	
4	Types of fuels burned	Fuel Oil		Fuel Oil		Pulv. Coal	
5	Mercury Turbine Generator Rating, Kw per Hr	10,000		15,000		20,000	
6	Steam turbine generator rating, Kw per Hr						
7	Steam output, Lb per Hr	124,000		210,000		325,000	
8	Total output, equivalent steam and mercury, Kw per Hr	22,400		34,100		55,000	
9	Mercury turbine throttle conditions, psig, FTT	70 psi	883 F	115 psi	947 F	125 psi	958 F
10	Mercury turbine throttle flow, Lb per Hr	1,080,000		1,640,000		2,143,000	
11	Steam conditions, psig, Deg FTT	400 psi	700 F	400 psi	700 F	400 psi	750 F
12	Total KwHr generated, actual or equivalent, as of January 1, 1950	1,724,440,686 (Net)		208,342,000		1,683,786,718	
13	Service Hours, as of January 1, 1950	119,082½		7,018		65,180	

Note: Line 12 is Total Kwhr based on actual mercury turbine Kwhr output plus equivalent Kwhr from steam generated, except for Schiller Station, which is actual total generation from the mercury and steam turbine units.

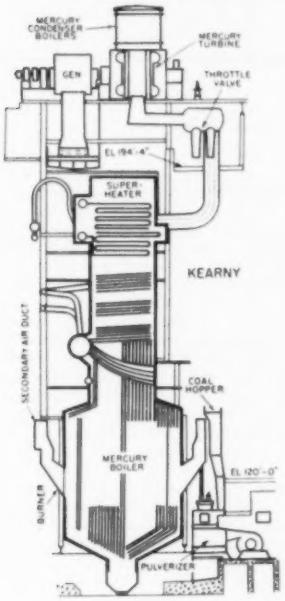
KEARNY

PITTSFIELD

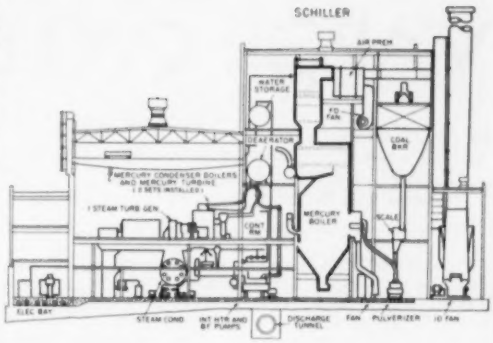
SCHILLER

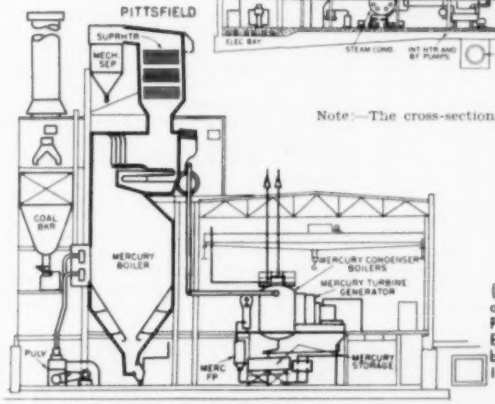
Meadow, 1928, to Schiller, 1949

Kearny Generating Station, Public Service Electric & Gas Co. Mercury turbine generator 20,000 kw, plus 290,000 lb per hr of 400-psi, 750-F steam



(Right) — Principal features of the complete mercury-vapor steam-electric installation, Schiller Station, Public Service Co. of New Hampshire. Two mercury turbine generator sets, each 7500 kw, plus one 25,000-kw steam turbine generator





Note:—The cross-sections are not to same scale.

(Left) — Principal features of mercury power plant at Pittsfield Works, General Electric Co.; Mercury turbine generator 7500-kw plus 124,500 lb per hr of 625-psi, 825-F steam

Design and Operating Data for Mercury Power Plants, as of January 1, 1950

Item No.		Public Service Electric & Gas Co. Kearny Generating Station	Public Service Co. of New Hampshire Schiller Station	General Electric Co. Pittsfield Works Power Station
	GENERAL PLANT DATA:			
1	Date placed in operation	1933	1949	1949
2	Location of Mercury Plant	South Kearny, N. J.	Portsmouth, N. H.	Pittsfield, Mass.
3	Type of service	Topping Existing Steam Generating Station.	Complete Condensing Power Generating Station.	Topping Existing Steam Generating and Process Steam Plant.
4	Types of fuels burned	Pulv. coal and fuel oil.	Pulv. coal and fuel oil.	Pulv. coal and fuel oil.
5	Mercury Turbine Generator Rating, Kw per Hr	20,000	2-7500 Units	7,500
6	Steam turbine generator rating, Kw per Hr		25,000	
7	Steam output, Lb per Hr	290,000		124,500
8	Total output, equivalent steam and mercury, Kw per Hr	45,000	40,000	20,000
9	Mercury turbine throttle conditions, psig, FTT	125 psi 958 F	113 psi 944 F	113 psi 944 F
10	Mercury turbine throttle flow, Lb per Hr	2,200,000	Each, 987,000	987,000
11	Steam conditions, psig, Deg FTT	400 psi 750 F	600 psi 825 F	625 psi 825 F
12	Total KwHr generated, actual or equivalent, as of January 1, 1950	3,105,453,000	8,852,100	36,426,050
13	Service Hours, as of January 1, 1950	86,603	534	2,154

Note: Line 12 = Total Kwhr based on actual mercury turbine Kwhr output plus equivalent Kwhr from steam generated, except for Schiller Station, which is actual total generation from the mercury and steam turbine units.

The MERCURY-VAPOR CYCLE

By W. N. OBERLY
Unit Equipment Division
General Electric Company
Schenectady, N. Y.

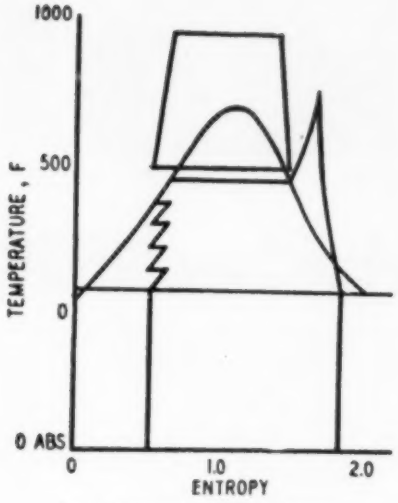


Fig. 1. Temperature-Entropy Diagram

THE MERCURY-VAPOR cycle is a binary cycle for producing power from fuel with greater thermal efficiency than is possible from the steam cycle alone. The mercury vapor cycle can also be considered as a steam cycle and, in addition, the by-product power from the mercury turbine generator is obtained at nearly the mechanical equivalent of the thermal energy. A typical temperature entropy diagram of the mercury steam cycle is shown in Fig. 1 where the steam portion of the cycle is a 600 lb, 825 F system with the usual feed water heaters in the liquid region. The initial mercury conditions are 140 psig, 975 F saturated. In order to transfer the heat from the condensing mercury vapor to the water, the mercury exhaust temperature must be higher than the saturated temperature of the steam to be produced. For economic reasons, this temperature difference is 30 F. The design back pressure of the mercury turbine to produce 600 lb steam is 2.58 psia.

The specific heat of mercury liquid is only one-thirtieth that of water at 80 F and one-sixty-sixth that of water at 650 F. Because of this, the mercury portion of the liquid line on the diagram is steep. This in turn means that nearly ideal temperature entropy conditions are inherent in the mercury and that no regenerative heating is required.

Figure 2 shows a typical flow diagram of the mercury steam cycle.

Heat from the burning fuel is absorbed by liquid mercury within the tubes of the mercury boiler to form mercury vapor, which passes from the boiler to the mercury turbine, where the vapor releases a portion of its energy to produce electric power. The vapor from the turbine is exhausted to the vacuum shell of the mercury condenser boiler. There it condenses and releases its heat of vaporization to water within the tubes. The liquid mercury is returned from the sump, or hot well, to the boiler by a mercury feed pump.

The water in the condenser boiler which absorbs the heat from the exhaust mercury vapor may be boiled into steam at any desired pressure. The steam so derived, after being superheated by re-circulation through tubes located in the gas passages of the mercury boiler, is available for driving a steam turbine or such other uses as may be desired. In effect, the condenser boiler which condenses the mercury vapor and boils the water is an evaporator which makes possible the use of water of poorer quality than could be tolerated in a conventional steam cycle.

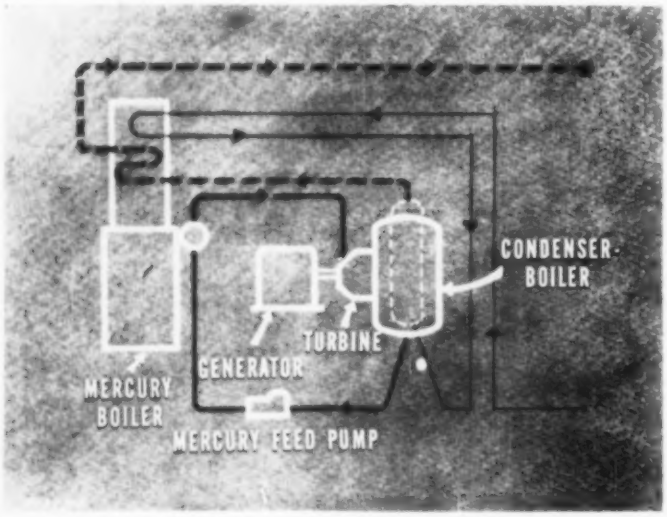


Fig. 2. A typical flow diagram of the mercury-steam cycle

Efficiency

The efficiency of a vapor cycle is largely determined by the temperature range through which it operates—the greater the range, the higher the efficiency of the cycle. This may be expressed by the equation, efficiency $E = \frac{T_1}{T_1 - T_2}$ when T_1

and T_2 represent the temperature range through which the cycle operates, in degrees absolute.

It makes a considerable difference whether the high temperature is obtained by increasing the pressure or by superheating the vapor. The energy required to superheat vapor to a certain temperature is only a fraction of that necessary to obtain the same temperature by increasing the pressure and maintaining the vapor in a saturated state.

The mercury cycle, superimposed on a steam cycle, boosts the efficiency of the resulting cycle because of the high boiling temperature of the mercury. For example, at 140 psig, mercury boils at 975 F, whereas at 1250 psig, water boils at 575 F. With 975 F mercury and a proper selection of steam and fuel conditions, thermal efficiencies of from 34 per cent to 38 per cent can be attained.

Mercury-Steam Cycle As a Topping Cycle

The mercury portion of a mercury-steam cycle can be considered as a topping cycle whether the lower steam portion is used to produce additional power such as at Schiller Station or for process work. Topping kilowatts, as such, require the expenditure of approximately 4000 Btu per hr from the fuel regardless of whether the topping power is produced by a steam topping turbine or a mercury topping turbine. However, mercury topping plants as generally applied, will produce about twice as many 4000 Btu kw's per lb of high pressure steam as can be secured from other topping cycles.

Figure 3 gives a clue to why mercury topping power ratios are so high and, therefore, in the case of the Schiller Station, why the overall station heat rate is so low. In this comparison, the total heat of the mercury vapor and its competitor, high pressure steam, have been corrected to the same total heat as is contained in one pound of 2300 psig 1050 FTT steam, or to 1497 Btu. For this total heat, 9.7 lb of mercury vapor must flow through a mercury turbine for each pound of 2300 psia steam flowing through a 2300 psia steam turbine.

As a basis for comparing the topping capabilities of these two cycles, the upper curve is a plot of the available energy of approximately 9.7 lb of mercury vapor when used to produce topping steam at various pressures in the mercury condensing boilers. The lower curve is a plot of the available energy of one pound of 2300 psia steam used in a turbine, exhausting at the indicated back pressures.

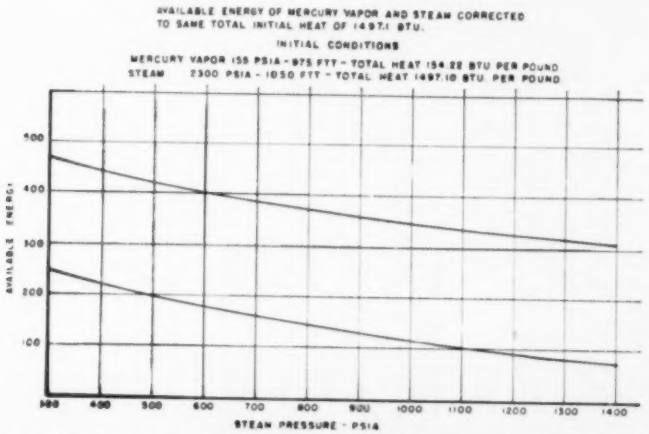


Fig. 3. This diagram gives a clue as to why mercury topping power ratios are so high, and why in the case of the Schiller Station, the overall heat rate is so low

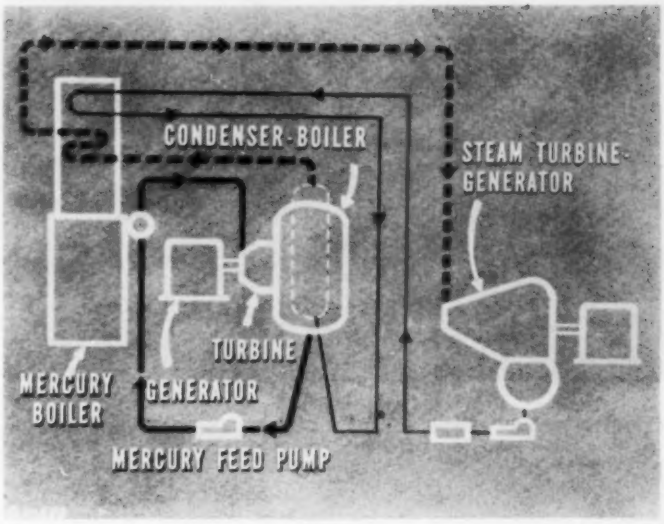


Fig. 4. Typical flow diagram of a condensing plant application such as at the Schiller Station

Energy Ratios Mercury To Steam

At 400 psig steam pressure the available energy ratio of mercury to steam is $\frac{442}{220}$ or almost exactly 2 to 1 and at 1250 psig the ratio is $\frac{320}{87}$ or almost 3.7 to 1.

The fact that the available energy of mercury vapor only changes some 27.5 per cent when producing steam in the condenser boiler at pressures varying from 400 psig to 1250 psig makes it possible to design standard mercury units for wide ranges of steam pressures with a relatively small change in mercury turbine output.

Over the same back pressure range, of a non-condensing steam turbine, the available energy of 2300 psia steam varies about 60 per cent.

Figure 4 shows a typical flow diagram of what we call a condensing plant application such as the Schiller Station. As its name implies, it produces electric power only. To accomplish this a condensing steam turbine, as shown in Fig. 4, of suitable size and design is included as a part of the mercury unit power plant. An application of this sort is usually added to power systems because of needed capacity brought about either by obsolescence of existing equipment or by increased power requirements. As a condensing plant application, the mercury unit power plant will produce power at the lowest plant net heat rate compared with other cycles of comparable size.

Schiller

Fig. 1. Exterior view of Schiller Station. The use of red brick and ample window areas for the lower portion of the building, all contrasting in color with the black prefabricated walls of the high boiler room, produces a completed structure, low in cost and modern in appearance

THE SCHILLER STATION is the first installation of a mercury unit power plant designed and built as a complete power generating unit. As a complete mercury unit power plant, the Schiller Station consists of two standard design 7500-kw mercury units and one 25,000-kw steam turbine generator set co-ordinated in design and rating so as to produce a power generating unit having a rated capacity of 40,000-kw.

Figure 2 shows a longitudinal cross-section drawing of the station looking south. The physical layout of the plant was established to facilitate equipment operation and to take full advantage of site terrain with regard to supplying the plant with necessary cooling and condensing water, and with fuel.

The condensing water intake screen house is located on the river bank east of the main building while the coal and fuel oil storage yards and the high tension switchyard are all suitably located on the high ground beyond the railroad tracks west of the plant.

The building is designed with the main entrance and lobby, the station supervisory offices, the testing laboratory and the electrical control and electrical switch bays all housed in the low extension on the extreme left, or eastern side, of the plant. The two 7500-kw mercury turbine generators and condenser boiler sets and the 25,000-kw steam unit, with their necessary auxiliaries and accessories, are located in the large turbine room shown in the left center of the station.

The two 7500-kw mercury boilers complete with their coal and fuel oil supply systems and other associated equipment are housed in the high boiler and coal preparation rooms adjacent to and west of the turbine room. Also located within this area are the various water treating, water storage and feedwater heating equipment, auxiliary power supply equipment, and other accessories required to produce a well-balanced and self-sufficient power plant.

The two induced draft fans with one centrally located stack, and the ash precipitation equipment are mounted in the low extension at the extreme western end of the building.

The Schiller Station is equipped to operate with either Bunker "C" fuel oil or pulverized bituminous coal as the fuel. Each of the two types of fuel burning equipment is of standard design with the exception that a set of low load fuel oil burners have been provided for each mercury boiler to satisfy expected station minimum load conditions.

When the plant is operating on Bunker "C" fuel oil, as is the case at the present time, the fuel oil flows by gravity from the main storage tanks into the 3000-gal station storage tank which is located in a concrete vault at the western end of the building.

The fuel oil is then pumped from this storage tank through the fuel oil heating system, metered, and finally burned in the mercury boiler furnace at the rate required to satisfy the station load demands.

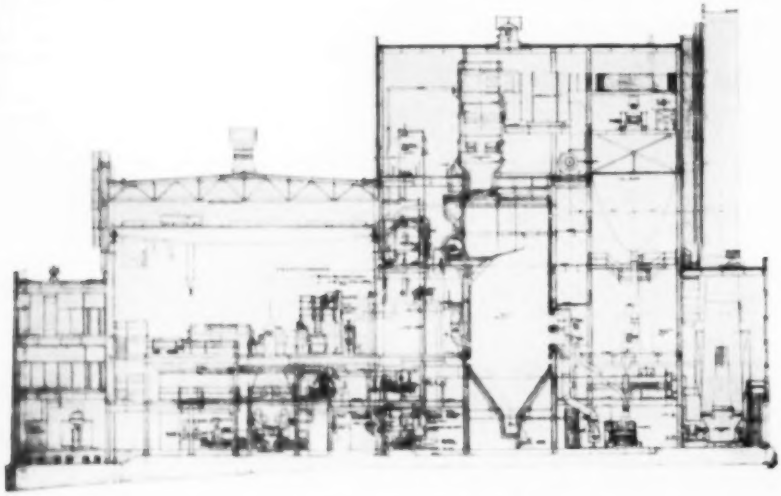


Fig. 2. A cross section through Schiller Station

Station, First Complete Mercury Unit Power Plant

Schiller Station, said to be the most efficient electric power plant of its size in the world, was officially opened by the Public Service Co. of New Hampshire on January 18. Consisting of two 7500-kw mercury turbine-generators, two mercury boilers, a 25,000-kw steam turbine generator and four condenser-boilers, it will have a net heat rate of 9200 Btu per kwhr

By **HAROLD N. HACKETT**, Construction Engineering Division, General Electric Company, Schenectady, N. Y.

When it is desired to operate the plant with pulverized bituminous coal as the fuel, crushed coal from the storage yard may be brought into the station by means of an inclined-belt coal conveyor which then distributes the coal to the 1000-ton coal bunker mounted in the coal preparation bay at the front of the two mercury boilers.

The coal flows downward from the coal bunker through suitable pipes; it is weighed and then pulverized before entering the furnaces where combustion occurs.

The fly ash produced from the burning coal will be caught by the fly ash precipitation equipment and removed from the station by means of a pneumatic ash removal system.

The entire station follows, to a considerable degree, the general design and arrangement of the usual steam generating station with only minor alterations in the equipment arrangement to meet the requirements of the mercury-steam cycle.

Building Design

The appearance of the building was designed with the idea of emphasizing the fact that the most modern and efficient equipment was used in this power plant. The building was functionally designed, and the pleasing modern appearance was accomplished by proper use of materials rather than by use of artificial ornamentations.

The building consists of a welded-steel frame resting on a reinforced concrete foundation mat laid upon solid rock. The low modernistic main entrance, and the use of red face brick and ample window areas for the lower portion of the building, all contrasting in color with the black prefabricated walls of the high boiler room bays, produce a completed structure, low in cost and modern in appearance.

The interior of the building was likewise designed to utilize materials and space to the best advantage. The suitable choice of functional colors for painting the equipment and interior building surfaces, together with the use of proper light intensities, has given the operating personnel a station attractive in appearance and easy to keep clean.

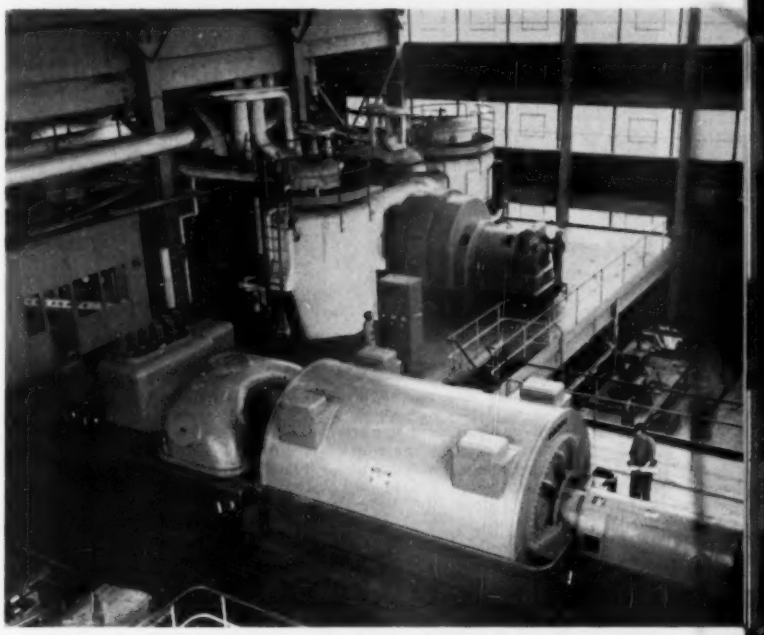


Fig. 3. The turbine room showing the 25,000-kw steam-turbine generator in the foreground and one of the two 7500-kw mercury-turbine generating units in the rear

The electrical control room is elevated above the turbine room floor so that the control room operator may have a complete view of the main operating floor upon which are mounted the two 7500-kw mercury turbine generator sets and the 25,000-kw steam unit. Such an arrangement may be of considerable value to the operating personnel in case of electrical troubles on the power distribution system or in case of difficulties within the Schiller Station itself. Likewise, should the Station inter-communications system fail, the electrical control room operator and the equipment and plant supervisory control room operators could more readily communicate with each other by speech or signals than if the arrangement of control rooms were less conveniently located in the station.

The actual control and operation of the mechanical equipment within the Station is from the centrally-located supervisory control room on the main operating floor. Practically all of the Station auxiliary equipment is started or stopped by suitable control switches from the supervisory control room, while the three main turbine sets must be manually started by hand control on each unit.

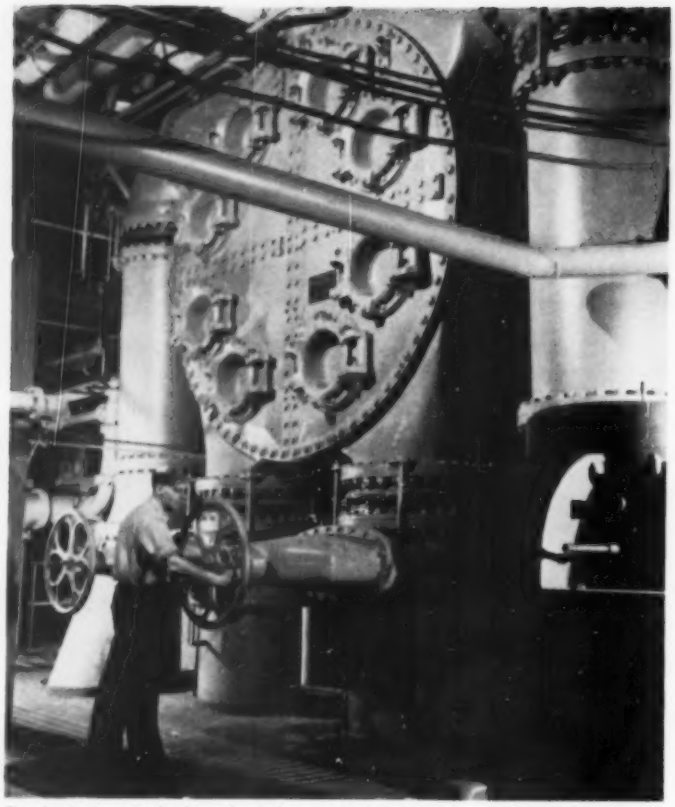


Fig. 4. A view on the lower level showing condenser for steam-turbine generating unit

When the main equipment is once in operation and "on line," the complete control and loading of the units is by either manual control or full automatic control from the supervisory control room.

The boiler room attendant should install, clean, or change the four fuel-oil burners per boiler as required, although the actual control of the firing rate is regulated automatically by the automatic combustion control equipment or manually as desired from the supervisory control room.

Operation

Unlike the usual steam generating station, when the plant is operated at base load, the two mercury turbines operate with their control and stop valves in the wide open position, thereby receiving their mercury vapor directly from the vapor drums of the mercury boilers. The electrical output from the mercury turbine generator is, therefore, a direct function of the rate of vapor generated by the fuel supplied to the mercury boiler fuel burners. The greater the electrical load demand, the greater the direct fuel requirements.

The effect of such an operating procedure upon the output of the 25,000-kw steam turbine generator is quite definite and positive, as the steam produced by the rejected heat of the mercury turbines' exhaust must be utilized by the steam turbine generator to produce some 60 per cent of the total electrical output of the station. Therefore, like the two mercury turbine sets, the electrical output of the steam unit, and subsequently the entire station, is really a direct function of the rate of fuel burned in the mercury boilers. An increase or decrease in the load demands upon the station must be satisfied by the quantity of fuel burned.

The station may be operated, if desired, to control the system frequency by proper manipulation of the steam and mercury turbine speed governors. At the present time, the station is operating as a base load unit, thereby utilizing this highly efficient power plant to produce the maximum amount of 9200 Btu kilowatts for use by the system.

The electrical energy thus produced is generated at 13,800 v, 3 phase, 60 cycle, and the output of the three generators is paralled on the 13,800 v bus from which outgoing feeders are run to the step-up power transformers located in the outdoor substation.

Auxiliary Power

Power for operating the station auxiliaries is taken from the main bus through two transformers which supply two groups of 2300-v auxiliary switchgear. Connected to each one of these groups is a load-center substation for the 460-v services.

All motors of 100-hp and above are supplied at 2300 v from the 2300 v switchgear while the integral horsepower motors of less than 100 hp are supplied at 460 v either directly from the 460 v load centers or from Cabinetrol groups located in the auxiliary switchrooms. A few motors are supplied through individual starters connected to feeders originating at the load centers. Fractional-horsepower motors and the station lighting system are supplied at 115 or 230 v through small air-cooled transformers connected to load center feeders.

Automatic equipment is used extensively for transferring auxiliary supply sources and bringing reserve auxiliaries into operation. An extensive annunciator system informs the control room operators of the occurrence of abnormal conditions in the operation of the station while

AVERY R. SCHILLER

President and General Manager

Public Service Company of New Hampshire

Avery R. Schiller was born in Spokane, Washington, in 1890, and came East for his higher education, receiving his Bachelor of Science and Master of Electrical Engineering degrees at Harvard University. After graduation, employed by the Stone and Webster Management Corporation, he rose in five years from statistical clerk to Superintendent of Distribution for a company serving a large area in New York State.

During World War I, he enlisted as an infantry private in the Army and was discharged as a First Lieutenant.

His war service finished, after several years with a firm of engineers, in 1924 he became Assistant to the President of the Manchester Traction, Light and Power Co. When the Public Service Co. of New Hampshire was formed in 1926, he was appointed Vice-President in charge of operations. In 1941, he became Vice-President and General Manager, and from 1942 to the present has been the Company's President and General Manager.

an automatic telephone system and separate loud-speaking paging system provide communication throughout the plant.

The plant heat balance was set up on two bases, one when the plant is burning Bunker "C" fuel oil and the second when the plant is operating with pulverized Eastern bituminous coal as the fuel. The station gross generation is expected to be the same when operating with either oil or coal as the fuel, although the final net send-out per hour from the plant will be slightly less with coal firing due to the additional power requirements of the coal preparation and certain other auxiliary equipment. The station net heat rate is lower when burning fuel oil because of lower auxiliary power requirements and higher boiler efficiency. When operating at design rating, the plant net heat rate when burning Bunker "C" fuel oil was expected to be 9200 Btu per net kilowatt hour and 9420 Btu per kilowatt hour when burning coal. In establishing the station heat balance, the mercury and steam pressures and temperatures were made conservative throughout, consistent with the basic requirements of high over-all plant efficiency, reasonable plant cost and plant maintenance.

The performance and operation of the plant to date, as viewed by the designers, has been very gratifying.

The operating personnel of the Public Service Co. of New Hampshire have had, we believe without exception, no previous experience with the operation of a mercury unit power plant. However, in an incredibly short time, these operating men have assumed complete operating responsibility for the plant with only minor supervisory assistance from the designers. This situation, of course, is the result largely of capable and efficient effort on the part of the operating personnel and, in a minor degree, of the operating simplicity of the mercury-steam equipment.

The designing, building, and operation of Schiller Station has been a successful undertaking, made possible only by the combined efforts of the owners, the designers, and the men whose job it was to fit the parts together.

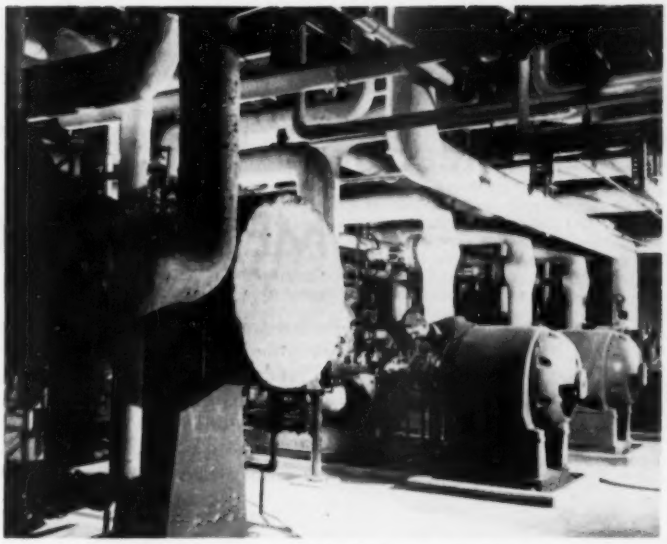


Fig. 5. This view shows one of the two boiler feed pumps supplying water to the condenser boilers at Schiller Station

Growth of Public Service Company of New Hampshire System

IN LESS THAN a quarter-century of operation, Public Service Co. of New Hampshire has increased its production of electric energy almost seven times. The addition by the company of the first completely integrated mercury unit power plant in this country at Portsmouth, New Hampshire, is typical of the way in which natural facilities and engineering achievement have been utilized in the system.

Public Service Co. of New Hampshire was incorporated on August 16, 1926. At the present time the company's installed capacity is 193,750 kw. This includes 31 hydro, 7 fuel-burning generating plants, 101 substations and approximately 761 pole miles of transmission lines and 4412 pole miles of distribution lines.

The company supplies electric service to more than 117,000 customers in an area containing 400,000 people, about 70 per cent of the population of the state. The company also supplies motor coach transportation service over 54 miles of route in and near Manchester, New Hampshire.

Shortly after VJ-Day, a 40-million dollar construction program was started to provide additional capacity required by a growing load and to replace worn equipment. The first step was the replacement of the floating power plant "Jacona", which was requisitioned by the government during the war. In November, 1946, a 30,000-kw floating power plant, the "Resistance", was purchased from the War Assets Administration. Completely remodeled and

(Continued on page 88)

Fig. 6. Boiler and turbine control panel room. Indicating board of annunciator system shows abnormal operating conditons. Mercury boiler control panels in background

South Meadow — First POST-WAR MERCURY POWER UNIT

Twenty-two years ago, the first commercial mercury turbine and boiler went into operation at the plant of the Hartford Electric Co. This unit ran successfully for nineteen years and was taken out in 1947 to make room for the new installation described in this article. This new, post-war unit is installed at South Meadow Station and produces a net 33,000 kw in the mercury turbine and the steam boiler condenser. The turbine alone produces 15,000 kw. This installation is the first of several post-war mercury units and now after a year's operation this detailed description has been released

By O. L. WOOD

Construction Engineering Division, General Electric Company

ON JANUARY 2, 1949, firing was started under the new mercury boiler installation in the South Meadow Station of the Hartford Electric Light Co., thereby putting into service another highly efficient power plant with resulting conservation of our natural resources. This unit of 33,000 kw net capacity from the mercury turbine and steam produced is the first of several post war Mercury Unit Power Plants in process of construction to be placed in service. It replaces the first commercial mercury equipment installed in 1928 by the General Electric Co. for the Hartford Electric Light Co. The initial installation was designed by W. L. R. Emmet, then Consulting Engineer of the General Electric Co. and his assistant, L. A. Sheldon and installed under the supervision of H. N. Hackett. The mercury cycle was developed by these pioneers to superimpose or "top" the then existing low pressure 250 psig steam cycle. Today, even with the practical maxima of pressure and temperature in steam generating equipment, the mercury cycle still can successfully top such units and increase the overall efficiency. The resulting economies, especially in the higher fuel cost areas, may be sufficient to pay off the additional investment in about three years.

First Unit

The first Hartford unit was built for 10,000 kw capacity 0.8 pf from the mercury turbine generator plus the production of 125,000 lb per hr of 250 psig 700 F steam.[1] The equipment was made of low carbon steel and some 3½ per cent nickel steel in the turbine and operated at a mercury boiler presure of 85 psig 908 F saturation temperature. Because of the ample factors of safety used in the original design, the steam pressure was increased to 400 psig in 1931.

To make way for the new equipment, the unit was taken out of service on Aug. 9, 1947 after 19 yr of continuous highly economical service with an availability factor of 85 per cent. During this time it had generated more than 1.7 billion net kwh. Metal deterioration at the high operating temperatures had resulted in reduction of capacity and reliability. The mercury charge in the old unit was completely evaporated and condensed in the condenser boilers and run into a storage tank for use in filling the new boiler and the old equipment was removed by January 1, 1948.

New Unit Design

In 1946, the Hartford Electric Light Co. in conjunction with the General Electric Co. made studies and finally contracted to replace the original unit with one of 50 per cent

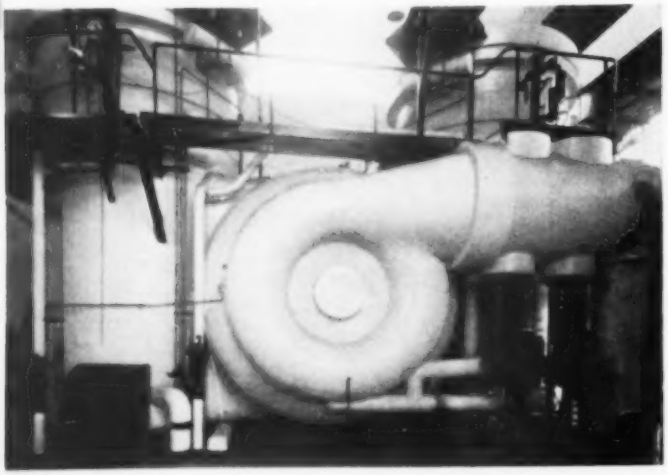


Fig. 1. The new 15,000-kw mercury turbine at the South Meadow Station of The Hartford Electric Co.

[1] Reference: "Experiences with the Mercury Boiler and Turbine" by Samuel Ferguson *Journal of the Franklin Institute*, Volume 220, No. 6 Dec. 1935 pp. 687-717.

greater capacity. The heat balance for the new mercury equipment is shown in Fig. 3.[2] A new mercury boiler design had been developed based upon the successful boiler installed in the Kearny Generating Station of the Public Service Electric and Gas Co. of New Jersey in 1939[3] but with certain alterations following the design and operating experience of steam boiler equipment. The new boiler was designed for 130 psig 964 F. saturation temperature at full load. This is 50 per cent higher in pressure than the original Hartford unit with a resulting increase in cycle efficiency and available energy. Fuel oil firing only was agreed upon. By using 340 F feedwater through additional bleed heating a very small economizer was required. Likewise a more compact regenerative type air heater was used in place of the original large tubular heater. Through these means the new equipment, with a generating capacity of 15,000 kw at unity power factor and the production of 211,000 lb per hr of 385 psig 700 F steam, was installed in the same space originally occupied by the first unit. A schematic arrangement of the equipment is shown in Fig. 2.

New Boiler

The new boiler built and installed by the Foster Wheeler Corp. to General Electric design is designed to produce 1,640,000 lb per hr of mercury vapor at full load flow when burning 17,400 lb of 18,500 Btu per lb fuel oil. Under these conditions the furnace liberation rate is 18,150 Btu per cu ft per hr.

A single drum 60 in. OD with a 2½ in. wall of chrome moly steel is used. It is 34 ft 5 in. in overall length and located along the rear wall of the furnace 30 ft above the furnace floor. Internal troughs and plates take care of distributing the return mercury which under full load conditions is at only half the drum temperature. Screens are installed in the boiler drum to protect the small bore furnace tubes from floating foreign matter. Internal baffles separate the liquid from the vapor so that the carry over through the four vapor outlets is negligible. Photograph, Fig. 7, is an internal view of the drum. Ten 12¾ in. OD 1 in. thick downcomers take the thermal circulating liquid mercury in the boiler which is approximately ten times the vapor outlet flow, into an equalizing manifold under the drum. The mercury liquid level is maintained within the 6 ft elevation between the bottom of the drum and the manifold. About 180,000 lb of mercury is required in the boiler system to do this. From each end of the manifold an external downcomer system feeds the lower furnace tube headers on each half of the boiler respectively. There are fourteen lower headers, four for each of the front and rear walls and three on each side wall. The down-comer system and lower headers are of 0.5 per cent chrome and 0.5 per cent moly material.

The tube lined furnace is 29 ft by 20½ ft by 44 ft high. It has a flat refractory floor which is built over the hot air ducts to the burners. Six Peabody Type H-26 oil burners are installed in the bottom 8 ft of the front wall, a refractory section, and the front wall, furnace tubes begin in headers just above this section. There are 196 1⅝ in. OD tubes on each of the front and rear walls, and 138 tubes on each side wall making a total of 668 tubes of 0.5 chrome 0.5 per cent silicon steel alloy material which has high oxidation resistance and is ductile in rupture. All the tubes are stepped up in size at three points to reduce circulation resistance. The front and rear wall tubes are continuous from the lower headers to the boiler drum, some reaching a length of 135 ft. They form the furnace ceiling and vertical slag screen at the furnace outlet and the arch on the rear wall, and are then bent into a series of sloping loops in a vertical plane which form the upper and lower banks of convection surface. This surface is often referred to as fog surface because of the similarity of the mercury liquid-vapor mixture in it to fog. The weight ratio of the vapor to the liquid of the mixture is approximately 7 to 1 in the highest heat absorbing circuit. The top end of the furnace side wall tubes enter three sloping headers behind each side wall. External piping carries

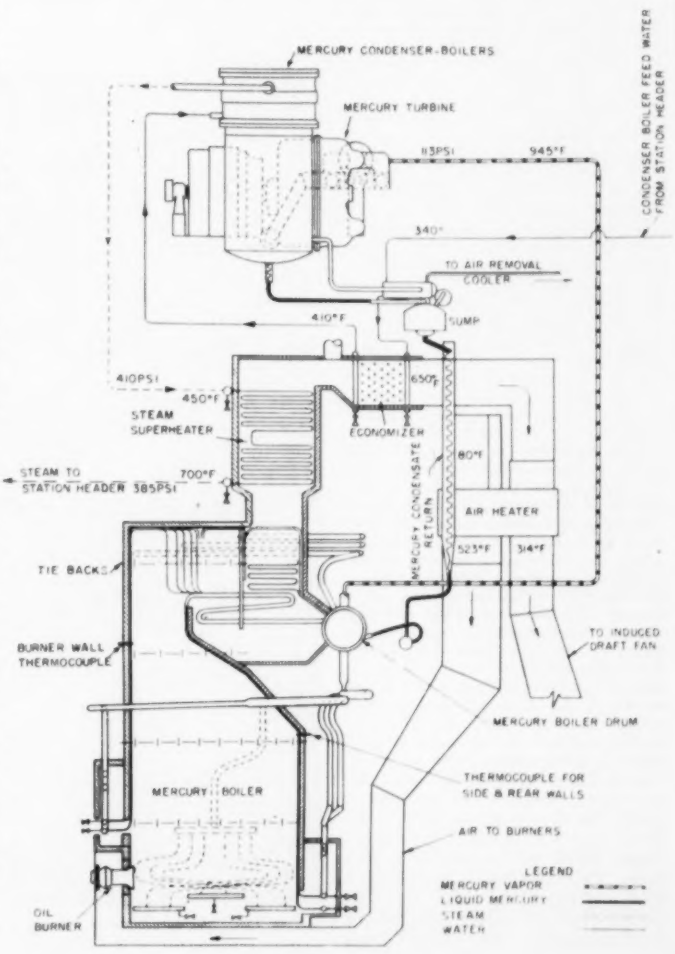


Fig. 2. Schematic arrangement of the new mercury plant at Hartford

[2] Reference: "Modern Mercury Unit Power Plant Design" by H. N. Hackett and D. Douglass at N. London A.S.M.E. Meeting May 2, 1949.

[3] Reference: "The Mercury-Vapor Process" by A. R. Smith & E. S. Thompson, *Trans. A.S.M.E.* Oct. 1942 "Mercury for the Generation of Light, Heat and Power" by H. N. Hackett *Trans. A.S.M.E.* Oct. 1942.

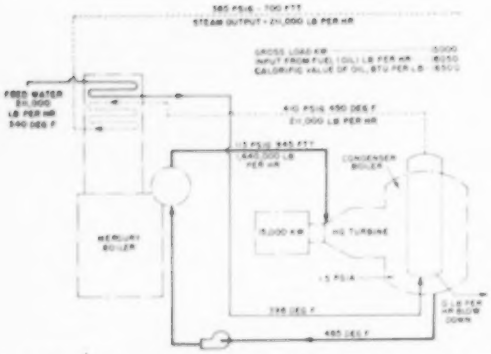


Fig. 3. Heat Balance Diagram of the mercury plant

the liquid vapor mixture directly from these headers into the boiler drum. Photograph, Fig. 4, is a view of the completed furnace looking toward the top from under the burner opening and showing the assembly of the slag and convection tubes.

In order to reduce field fabrication the furnace tubes were shop assembled to the lower headers, and also the upper headers for the side wall tubes, stress relieved, and shipped in sections. Upon erection these sections almost completely formed the furnace walls. The front and rear wall furnace tubes are held by a fixed support about 15 ft below the top of the furnace while the side wall tubes are supported at the top. As the unit comes up to temperature, the side wall tubes which have the greatest movement expand downward so that the lower headers move 3 in. This requires adequate flexibility in the down-comer system to prevent overstressing.

The flue gases upon leaving the mercury convection surface at a temperature of 1200 F pass through a steam superheater, water economizer and air preheater. The superheater, built by the Foster Wheeler Corp., is installed in two sections in the flue above the mercury boiler and is of the continuous tube type. The heating surface consists of 8530 sq ft of 2 in. OD tubing. It superheats the saturated full load steam produced in the condenser-boilers to 700 FTT. The economizer is a Foster Wheeler extended surface design for horizontal flow of flue gases and contains 5280 sq ft of surface. The 340 F feedwater from the station boiler feed system is heated to 410 F as it passes through the economizer in circuit to the condenser boilers. A regenerative type air heater supplied by the Air Preheater Corp. is used to heat the combustion air to 500 F. The forced draft fan is an American Blower Corp. type H.S. No. 537 single inlet, single width and operates at 1125 rpm. The combustion air is taken from the top of the boiler room by means of an air shaft to the forced draft fan inlet. The induced draft fan was also supplied by the American Blower Corp. and is a Sirocco No. 10½ double inlet, ½ double width and operates at 673 rpm. Both fans are equipped with hydraulic couplings for speed control and the only damper installed is a shut-off damper in the stack.

Piping

Four 12¾ in. OD by 13/16 in. wall 0.5 per cent chrome 0.5 per cent moly pipes carry the vapor generated in the boiler to the turbine. These pipes enter a 36 in. OD vertical bottle shaped manifold just ahead of the stop valve. Each one of the vapor pipes is about 110 ft in length and carries the vapor 34 ft vertically from the drum to the manifold. The vertical full load expansion absorbed by each pipe is 4 in. The vapor piping, manifold, mercury return pipe and steam piping were shop fabricated by the M. W. Kellogg Co. and field erected by the same concern.

Turbine-Generator

The mercury turbine generator set, designed and manufactured by the General Electric Co., is to some extent a rebuild and quite similar to the original unit. It is a horizontal shaft two bearing set having the turbine rotor overhung with the high pressure section on the outer end. The original turbine exhaust hood was returned to the factory, suitably machined and a large assembly flange welded to the face of it. The turbine is a five stage im-

Fig. 4. View of the completed furnace, looking toward the top from under the burner opening

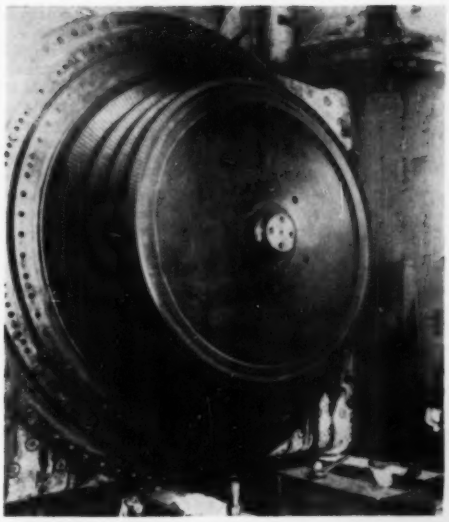
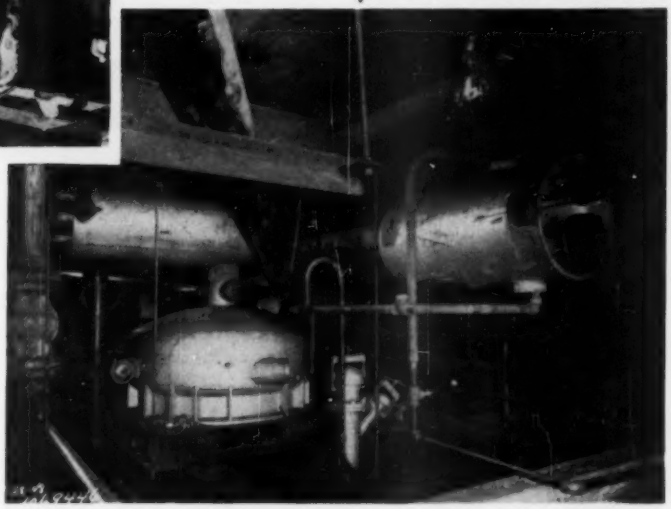


Fig. 5. (Left) A view of the mercury turbine rotor preparatory to diaphragm assembly

Fig. 6. (Below) The sump, the primary cooler on top of it, the return lines from the condensers entering the connection between the two, and the flash tank to the right



pulse type machine, operating at 720 rpm with a full load bowl pressure of 113.5 psig and a back pressure of 2.4 Hg abs or 3.2 in. abs. The variation in back pressure is dependent upon whether 300 psig or 410 psig steam is being generated in the mercury condenser boilers. Operation with either pressure is obtained by simply valving the superheater outlet to the 275 psig or 385 psig station header.

The four diaphragms in the turbine are fitted between the pin bushed wheels beginning with the 5th stage after the rotor is in place. Photograph Fig. 5, shows the rotor preparatory to diaphragm assembly. The diaphragm joints are staggered either on the horizontal or 45 degree clockwise or counterclockwise from it. Outside supporting rings for the 2nd, 3rd and 4th stages stack to form an inner shell which is bolted to the heavy outer ring of the 5th stage diaphragm. The latter is fastened to a large flange on the face of the exhaust hood. The 2nd and 3rd stage diaphragms are pin supported at the horizontal line in their respective outer rings, while the 4th stage is on crush pins. Standard slant tooth spring back interstage packings are used. A moly vanadium cast outer shell slips over the stacked rotor-diaphragm assembly like a cap and bolts to the outside edge of the exhaust hood flange to which the diaphragms are bolted. The outer shell is centered on a gib and supported on either side at the horizontal joint by posts. A scroll on the outside end of the shell is the turbine inlet bowl with the 1st stage nozzle welded into the inner side of it. The vapor inlet to the bowl enters the scroll tangentially on the top right side with its axis horizontal. Photographs, Fig. 1, shows the turbine, completely assembled with the control and stop valve connected to it.

The generator armature and field were rewound for the increased generating capacity of the unit. The generator air cooler was replaced with one of greater cooling surface. Excitation is by the original separate motor driven exciter.

Condition of Original Turbine

When the original turbine was dismantled in 1947, it was the first time in 16 yr that it had been opened. There had been no bucket, diaphragm or packing failures. The 1st stage nozzle, 2nd, 3rd and 4th stage buckets and diaphragm partitions were still in excellent condition with little or no pitting or cutting. The 1st and 5th stage buckets were eroded on the entrance edge and the 5th stage diaphragm partitions were eroded on both entrance and exit edges. The excellent condition of the unit after 116,000 hr of service was due to the fact that liquid mercury was readily thrown out into the interstage drains in all except the 5th where the percentage moisture is high and also that there is not any water or moisture present in a mercury vapor system to cause corrosion. The lack of any corrosion in a mercury turbine greatly prolongs the life of its internals. For the same reason corrosion resistant buckets and diaphragm partitions are not required.

Boiler and Turbine Control Valves

The turbine stop and control valve manufactured by Schutte & Koerting to General Electric design consist of two double disc valves 28 in. in diameter built into one 4 ft dia cylindrical cast moly vanadium body. Both valves are hydraulically opened against springs by the turbine lube oil pressure. The control valve is not actuated by a speed governor but is used only for starting or stopping the unit. This is done manually or electrically through valving in the hydraulic system. Normally both the control and stop valves are opened wide and loading of the unit, which floats on the electrical system, is controlled by changes in boiler firing. Because of its high efficiency the mercury installation usually carries base load.

For overspeed control a double ring emergency governor was built on the collector ring end of the shaft. One emergency governor trips the stop valve shut at 109 per cent speed while the other trips the control valve at 110 per cent. On the entering, or boiler side of the main valve casing, are connections to two mercury boiler relief valves. These are used to vent the mercury vapor from the boiler directly to the mercury condenser-boilers in case of over pressure or on loss of lubricating oil pressure. The energy in the vapor would, therefore, pass directly to the steam end of the cycle and either be used there or vented through steam safety valves to the atmosphere. The mercury relief valves are closed hydraulically by

the turbine lube oil pressure. Pilot valves, actuated by the mercury vapor pressure on the boiler side of the stop valve, control the lube pressure to the relief valve oil hydraulic cylinders, so that the latter will vent the vapor from the boiler when required. The hydraulic control is arranged to fail safe i.e. if the lube oil pressure drops below normal the control and stop valves will close, the mercury relief valves will open. The stems of the above valves are sealed by all welded bellows to prevent mercury leakage. The bellows on the control and stop valve are almost 3 ft long to take care of a valve lift of 3½ in.

Condenser Boilers

On the new installation, the steam drums of the two condenser boilers and the condenser shells are the original ones installed in 1928. The condenser boilers were retubed with 3 in. OD by 14½ ft dead end steel tubes. Internal recirculators were installed in each tube to conduct the thermal circulating water to the bottom and to cause sufficient turbulence there to prevent the deposition of solids. The mercury turbine exhaust vapor, entering the partially laned tube bundles in the condenser boilers, gives up its heat of vaporization as it condenses on the outside of the tubes. The liquid mercury falls to the bottom of the condensers from where it is piped to a sump in the return system. The heat transferred across the condenser-tubes, at a full load average gradient of 39 F, is absorbed by the water to form steam at the desired pressure in the steam drums. The saturated steam is piped externally from the drums to the inlet header of the steam superheater.

Non-Condensable Removal System

In order to exhaust the non-condensables from the mercury condensers and thus from the entire mercury system, a hexagonal box is installed around several of the condenser tubes near the center of each condenser tube bundle. Holes are located in the sides of these boxes, graduating in size from the top to the bottom where a 6 in. pipe connection is made. This pipe passes through the side of each condenser to a primary cooler which sits on top of the sump in the mercury return system. In this cooler the entrained mercury vapor, which under existing partial pressure is a part of the non-condensables removed when the unit is under load, condenses on pipe coils through which the feed water passes enroute to the economizer and steam drums of the condenser boilers. The condensed liquid runs through a trap into the sump while the non-condensables pass from the cooler through connecting piping to a secondary cooler where any vapor still present condenses on coils cooled by a circulating fresh water system. The non-condensables are then removed from the secondary cooler by either a steam injector or Kinney vacuum pump.

Fig. 7. An internal view of the mercury boiler drum

Mercury Return System

The duty of the sump which is a part of the return system is to remove by flotation in a low velocity section any large foreign matter in the returning mercury. In addition, since the mercury inlet is liquid sealed and it has a direct connection to the secondary cooler, a higher vacuum is produced in the sump than that in the condenser boilers. This flashes a portion of the returning mercury into vapor. This vapor, acting as a dust carrier, passes from the top of the sump into a cooler or flash tank, so named because of the flashed vapor it receives. Magnesium oxide dust is formed by the mercury treatment. This dust which the vapor continuously removes from the sump when in service is deposited out in the flash tank. The vapor is condensed and returned to the system through a trap. Photograph, Fig. 6 shows the sump, the primary cooler on top of it, the return lines from the condensers entering the connection between the two, and the flash tank to the right. In the foreground is the titanium injector on the sump outlet connection to the spiral ramp.

The mercury turbine and condenser boilers were installed above the boiler in the original unit in order to use gravity return for the condensed vapor. This same system was utilized on the new unit, but because of the higher boiler pressure or back pressure on the return line, considerable calculations were required to properly locate the various parts of the return system and design them for minimum pressure drops commensurate with as low a mercury content as possible. The main element in the return is a spiral ramp which lowers the mercury 24 ft vertically from the sump outlet to the boiler drum elevation. The ramp and the various mercury coolers referred to, as well as the titanium and magnesium injectors and the mercury pump and storage tanks, were built by the Whitlock Manufacturing Co. to General Electric designs. Expansion movements in the direct connected return system were absorbed by Cook Magnilastic joints.

Mercury Treatment

Through many years of experience and study, treatment of the boiler mercury has been found to be a necessity to insure uniform and reliable heat transfer throughout the various mercury boiler circuits. It likewise is required to prevent the slow dissolving action of the furnace tubes by the mercury and the resulting deposition and plugging of the tubes where the mercury becomes oversaturated with iron.

Solution for these two problems was to add to the mercury in the boiler metallic magnesium and powdered titanium. The titanium forms a titanium steel alloy layer on the internal clean oxygen free tube surfaces which definitely inhibits the solution of the iron. After 8 yr of service with this treatment, the internal surfaces of tubes from the Kearny

mercury boiler still show the original die marks. The magnesium is the cleaner, or deoxidizer, of the mercury system, since it has the greatest affinity for oxygen. The magnesium oxide formed during this scavenging action is a light gray dust which flows along with the vapor as a carrier to the turbine and condenser boilers. Here it is washed down into the sump where the flashing action described previously continually removes it from the system.

In addition to, and as a result of the above actions, the presence of the magnesium and titanium produces a "silvering" or wetting of the internal surfaces of the boiler tubes with a cohesive mercury film. This positively established a heat transfer medium from the boiler tubes to the circulating mercury which will absorb heat at rates far in excess of those encountered in a non-treated boiler, without overheating.

The metallic magnesium is added to the boiler when the unit is in service through an injection tank which is in a by-pass line around the main return system. The injection tank is valved off so that the head can be removed and as many as four 2-ft lengths of 1.3 in. diameter metallic magnesium bars inserted. After the head has been replaced, the valves are opened which permits the hot condensate mercury from a reservoir in the bottom of the sump to circulate through the tank dissolving the magnesium and carrying it into the boiler. The titanium is added as titanium hydride powder through a titanium injector located on the return line between the sump and the spiral ramp. The hydride powder in amounts required is placed in the injector while the latter is still sealed off from the return line. With the cap on the injector, a plunger valve is opened in the bottom of the injector which produces an inrush of air from the injector into the return line thus carrying the powder in with it. The powder is caught by the returning mercury and carried into the boiler. The amounts of the two metals maintained in the boiler mercury are 1-2 ppm of titanium and 80-100 ppm of magnesium. This is checked by the station chemist daily in samples drawn from sampling connections on the main downcomers on each side of the boiler.

Air Leakage

To reduce the amount of magnesium loss by oxidation and the resulting amount of oxide formed, air leakage must be kept to a minimum. The greatest source of leakage after getting the all welded mercury system tight was originally around the turbine shaft seal since this was on the vacuum end of the machine. In order to start the boiler and turbine the system has to be evacuated first while the shaft is stationary. To seal the shaft in this condition an auxiliary motor driven vertical shaft centrifugal mercury pump is used to flood the annular clearance between the turbine packing casing labyrinth and the labyrinth on the turbine shaft sleeve. The shaft seal pump is located on one side of a U-shaped cooler-pump tank arrangement with the cooler in the opposite leg which is connected to the reservoir in the bottom of the sump. The large flow of mercury required to seal the turbine shaft is returned to the pump via the sump either through the turbine exhaust hood and condensers-boilers or through a separate drain pipe from the outer atmospheric chamber of the turbine packing casing. After the turbine is started and brought to speed another arrangement is used to seal the shaft with less friction and cooling losses. A continuous cup is built on and around the shaft inside of the outer end of the turbine packing casing. A continuous lip from the casing projects into the cup. When the shaft is up to speed mercury is supplied to the cup and is held in it by centrifugal action. The stationary lip projects into the mercury liquid in the cup so that full vacuum may be obtained on one side of the lip with atmospheric pressure on the opposite side with only a level differential of mercury between the two sides of ⅛ in. Mercury is circulated through the cup to prevent the lip from overheating. This is accomplished by vacuum which lifts the mercury from an external atmospheric "running" seal cooler into the vacuum side of the cup. The mercury passes through the cup, overflows the lip on the atmospheric side and then drains back to the running seal cooler.

Additional air leakage, as well as mercury leakage, protection is obtained by having all the valves on the system of a sealed stem design. Some valves are packed with "Teflon" and others with various types of bellows, the majority being furnished by thet Fulton Sylphon Co. Non-condensables removed under full load operation runs about ½ of a cu ft per hr.

To prevent hot mercury from oxidation where it may be exposed to the atmosphere such as in the shaft seal pump tank or in the outer compartment of the turbine shaft packing casing, blanketing with inert gas is used. The gas is obtained from two sources. Tank nitrogen is used in the shaft seal pump tank and a combination of nitrogen and CO_2 obtained by the combustion of propane in an atmosphere converter is used in the packing casing and other parts of the equipment. Among the latter is the mercury storage tank. This tank, which is located in the basement, is 4 ft in diameter and 25 ft long and will amply hold the 200,000 lb of mercury used to fill the entire mercury system. Filling the boiler is accomplished by means of another motor driven vertical shaft centrifugal mercury pump which is mounted on the lower sump end of the tank. Both mercury pumps were manufactured by Buffalo Pumps, Inc. to General Electric designs. In case of an emergency the entire mercury system may be drained from the return feed line at the drum into the storage tank in a matter of minutes. Each of the fourteen lower headers of the boiler may be drained independently to the storage tank for maintenance on the furnace tubes when required.

Instrumentation

Warning of the gradual loss of mercury treatment in the mercury boiler, the stoppage of circulation for any reason or the indication of a mercury leak, is dependent upon the reliable operation of two instruments. These are the Multi-point Boiler Tube Temperature Recorder and the Mercury Vapor Detectors which were furnished by the General Engineering and Consulting Laboratory of the General Electric Co.

The boiler tube temperature recorder indicates an hourly check of the operating temperature of every one of the 668 mercury furnace tubes. A high oxidation resistant thermocouple is installed in a thermocouple well shop fabricated on the rear of each furnace tube about 20 ft above the lower headers. The couples pass through the boiler casing to external cables which connect all the couples to individual sets of bus bars in two switch cabinets of 400 contacts each. Each cabinet has a brush contact pick-up on a cross-arm which moves vertically up and down, making contact with 200 couple bus bars on the up stroke and 200 more on the down. Relays operate the motors driving the cross-arms in both cabinets so that one will follow the other and then repeat the cycle. As the brushes on the cross-arm make contact with each set of bus bars, a Leeds & Northrup instrument on the Boiler Room Control Board records the thermocouple reading. Readings are recorded in groups of 25 for checking tube numbers, and upon the completion of every two groups, the mercury boiler saturation temperature is recorded as a standard. If any tube temperature exceeds 1100 F a visual and sound alarm is given.

The Mercury Vapor Detectors of which there are two types are located on the Turbine Room Control Board. Both operate on continuous samples of flue gas drawn from the stack by a Bailey Meter Oxygen Sampling System. One is known as an Electronic Detector and works on the principle of a change in the ultraviolet light pick-up by two balanced phototubes if mercury vapor is present in the flue gases continually passing between the ultraviolet light and one of the phototubes. A ½ cc of mercury

(Continued on page 75)

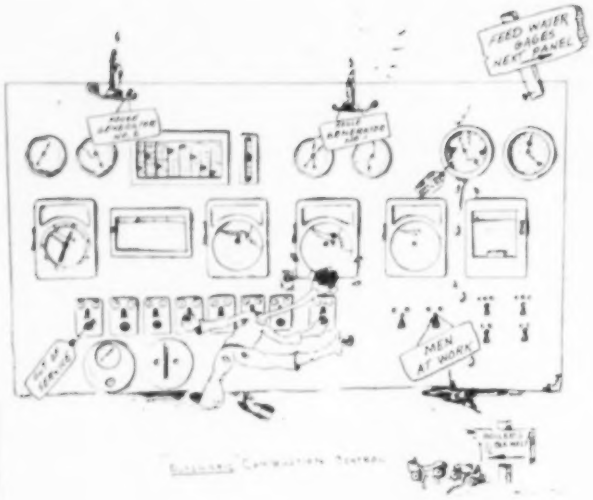


Fig. 1. This shouldn't happen to you, but it gives an idea of what *might* happen during preliminary operation or in case of trouble

Increasing personnel costs lead to more control centralization . . . But this leads to panels 30 ft long and hundreds of indicators, recorders, adjusters, controls, signal lights and alarms . . . How much one man can handle effectively during trouble influences extent of centralization . . . Ease and reliability of operation determine panel arrangements . . . Advantages and disadvantages of complete centralized control . . . For initial units, controls can be centralized but as units are added, better to have individual control point for each turbine-boiler unit with centralized electrical control room for all . . . Smaller instruments and controls needed to shorten panel boards

By
B. C. MALLORY,
Chief Mechanical Engineer,
Stone & Webster Engineering Corp.

Centralized Controls for Steam Electric Power Stations

ULTIMATE in centralization of instrumentation and controls for a steam-electric power station might be considered as only one operator for the whole station, this operator sitting in a quiet, air-conditioned office with one load indicator and one control to start, adjust the load and stop each main turbine generator. The boiler for each unit and all other equipment would operate automatically and the man's only duties would be to operate the load controls in accordance with telephoned instructions from the system load dispatcher. However, this ultimate in simplification is neither economical nor feasible for present day steam turbine generators, boilers and auxiliary equipment.

Once started and put on the line, a turbine with its boiler and complete set of auxiliaries may be so equipped today that it can be operated automatically. But present day equipment and controls are not sufficiently trouble-free even with the best of maintenance programs and are not trusted to operate satisfactorily without adequate attention. Nor, so far as the writer knows, have automatic controls been devised to start either a turbine or a large high-pressue boiler from cold without manual assistance and careful checking by operators.

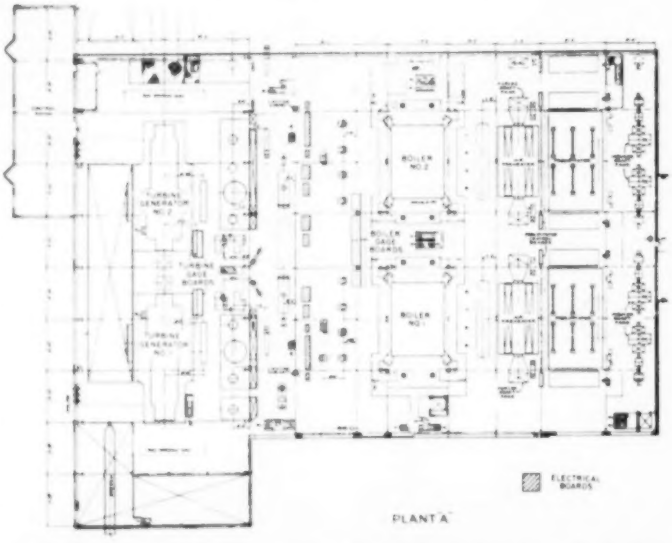


Fig. 2. Main operating floor plan. Plant A, a new station containing two 850-psi, 900-F, 80,000-kw turbine generators and two coal-fired boilers

Editor's Note—Already some of the new stations are designed to segregate operating controls for minute-to-minute operation, putting historical recorders on separate panels out of the way. Further details of how a modern station's centralized controls were organized are given in another AIEE meeting paper by B. F. Bergel, which will be published in a subsequent issue.

That paper also outlines some interesting suggestions for arranging control using transmitters, controlling boiler as well as turbine from phase angle control of tie line loading and frequency, control room lighting.

See also New Ideas in Control Room Lighting, by Frank P. Kuhl, Power Generation, August, 1948.

Can We Have Automatic Starting Controls?

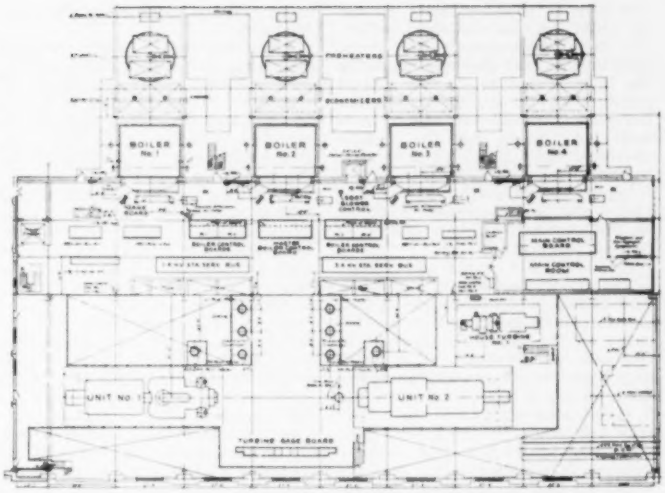
A vast amount of thought and effort should be applied to developing reliable controls for automatic starting of boilers and turbines, especially from an overnight standby condition. Managements are asking engineers to consider seriously some automatic time-clock device, possibly with temperature and vibration sensitive adjustments to coordinate starting procedures properly, both from the viewpoint of uniformity of operations and ease of control. According to "Cybernetics" by Norbert Wiener, "automatic factories without human agents, are only so far ahead of us as is limited by our willingness to put such a degree of effort into their engineering as was spent, for example, in the development of the technique of radar in the second world war."

Separate control points for each turbine generator and each boiler have been common practice in the past, with a separate switchboard room. Now, with increasing costs of operating personnel, more emphasis is being given to aggregating main control points at centralized locations in order to require the use of the fewest possible men. For medium or large modern boilers or turbines, each control point may require an instrument and control board as much as 30 ft long, and each panel becomes complex with literally hundreds of items of indicators, recorders, controls and alarm lights. To assemble several of these boards at a central location requires considerable space. Factors involved in design of such centralized controls and data on specific installations, as given below, were presented by the author in this paper before the AIEE Winter General Meeting, New York City, January 30 to February 3, 1950.

How Much Centralization?

Wide divergence of opinion exists among designing and operating engineers with regard to the amount of centralization of control that is practicable. The problem of the extent of advantageous centralization revolves about the number of manual controls that can be handled by one man in time of trouble. The cartoon, Fig. 1, illustrates and emphasizes what happens when there is trouble.

One man can supervise many controls while everything is functioning properly and units are neither being put on nor taken off the line; but, in times of trouble, the number and complexity of the controls that one man can handle depend to a large extent on the panel layout and the ability of the man. The number can be increased safely to some extent by a logical arrangement and use of different types of control handles for different types of control so that routine adjustments become simplified and, in emergencies, the operator acts from habit without having to think out each step of what he should do.



PLANT "B"

Fig. 3. Main operating floor plan, Plant B, a new station containing two 850-psi, 900-F, 60,000-kw turbine generators and four oil-and-gas-fired boilers; station recently extended with two more 60,000 kw units

Too often the artistic appearance or the space needed behind the panels for instruments has governed the board layouts. There is a need for miniature mechanical instruments comparable to those on electrical boards or to those used for large airplanes. Furthermore, for ease and reliability of operation, the instruments and controls should be segregated to permit manipulating the vital controls from a central point, while those having minor manual adjustments for efficiency and the historical items, are located at some less strategic point.

Advantages of Complete Centralized Control

Advantages of complete centralized control, with the switchboard located in the control room, include:

1. Reduction in number of operators, which minimizes cost of operating personnel.
2. Presentation of all pertinent data to one operator to give a better understanding of the plant as an integrated, coordinated unit.
3. Ability of operator to take corrective action simultaneously for two or more operations, if conditions demand.
4. Avoidance of communication errors.
5. Improvement in quality of operation. The better operating conditions of the centralized control room attract a higher type personnel. This means more than better thermal efficiency, for it should give better maintenance of load during upset conditions, quicker restoration after an interruption, and better judgment in preventing an interruption.
6. More automatic controls may be required, which tend to free the operator from details and permit more supervision.

Disadvantages of Complete Centralized Control

Disadvantages of complete centralized control with the switchboard located in the control room include:

1. Space required for control room in heart of station. Add to initial construction cost by adding building space and may add it for the full height of the station.
2. Each additional instrument and control adds equipment to be maintained and each is a potential source of trouble because it may function incorrectly.
3. Complexity of many instruments, controls, alarms and lights requires a considerable training period for operators, especially if the mechanical and electrical men have to substitute for one another. With two mechanical men and one electrical man in a control room, this substitution might easily be required.
4. Added cost, due to either duplication of controls, or longer runs of instrumentation and control leads and the space required for them.
5. Higher rate of pay for operators having greater responsibility.

Four stations designed since the war, each with two 40,000-kw or larger turbine generators, illustrate differing amounts of centralization of control.

Details of Plant A Controls

Figure 2—Plant A shows the main operating floor plan of a new station

which has two 850-psi, 900-F, 80,000-kw units and two coal-fired boilers. The two boiler panels have been combined so that the men operating the boilers have a common control point. The two turbine generators have been located with their steam ends together so that the turbine operators have control points close together. The electrical control room is separate, just outside the turbine room, and approximately centered on the expected ultimate station of four or five units.

Operations are limited to two floor levels, with a few minor exceptions. The forced- and induced-draft fans and the precipitator controls are located on the operating floor grade for ease of operation. The 440-v switchgear is also on the operating floor, as shown cross-hatched in Fig. 2. Boiler feed pumps and their controls are located on the ground floor with the condensate and booster pumps. Boiler feed pump controls are duplicated on the boiler boards.

The complexity of even this relatively minor centralized arrangement may be emphasized from the following:

These two boiler panels are each 19 ft long, or a total of 38 ft for the two, and each has 42 indicators, 18 recorders, 6 controllers and 25 sets of start and stop pistol grip control switches, usually with 3 lights per switch. There are over 300 items for the two boilers. Each turbine panel is 13 ft long and has 7 indicators, 10 recorders, 8 sets of start and stop push buttons, usually with 3 lights per switch. Communication between the electrical control room and the boiler and turbine rooms is by telephone and telautograph.

One company preferred this arrangement and objected to combining the boiler and turbine gage boards on the basis that boiler and turbine operators are not readily interchangeable, each having very different duties. In some localities, with the arrangement shown, a boiler operator with a helper to patrol the boiler operating floor, and a turbine operator with a helper, are required; so that combining the boiler and turbine boards, or placing them close together in a separate room, would not decrease the number of operators.

Details of Plant B Controls

Figure 3—Plant B shows the main operating floor plan of a new station with two 850-psi, 900-F, 60,000-kw turbine generators and four oil-and-gas-fired boilers. The station has recently been extended with two more 60,000-kw units. Here the electrical control room was placed in the aisle between the boilers and the turbines at turbine operating floor grade, and is centrally located in the completed station. The boiler boards are grouped together as are the turbine boards.

For the equipment in the picture there are 110 lin ft of mechanical gage boards, which have over 300 functions for indicating, recording and controlling, not including lights and alarms for condensate, boiler and turbine controls.

Details of Plant C Controls

Figure 4—Plant C shows the main operating floor plan of a plant ex-

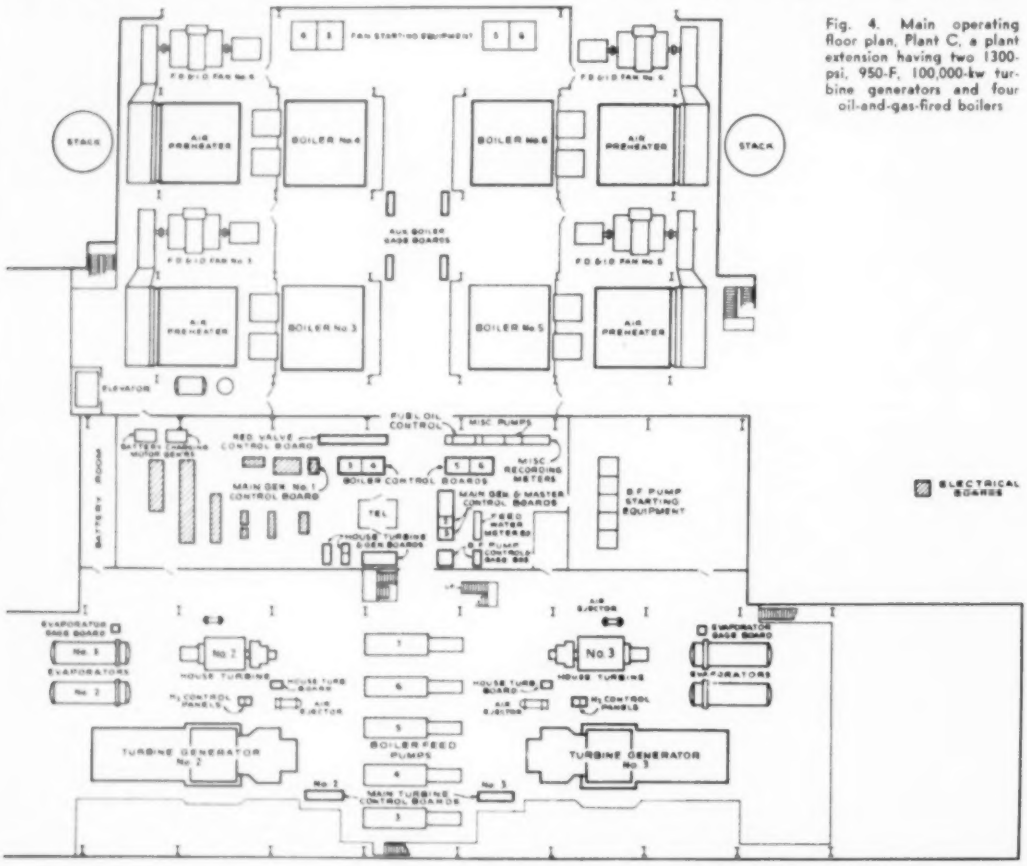


Fig. 4. Main operating floor plan, Plant C, a plant extension having two 1300-psi, 950-F, 100,000-kw turbine generators and four oil-and-gas-fired boilers

PLANT "C"

tension having two 1,300-psi, 950-F, 100,000-kw turbine generators and four oil-and-gas-fired boilers. This extension has a complete centralized mechanical and electrical control room located at operating floor level so that it is at the crossroads between the boiler and turbine rooms. In addition, there are individual gage boards at the various equipment items.

The control room is 40 ft by 130 ft. The man stands at the boiler master panel, and there is an enclosed telephone booth. There are 378 annunciator drops in this room. Some control rooms are soundproofed and air-conditioned, but this utility soundproofs only the glass-enclosed telephone booth and prefers to have the operators noise-conscious with respect to characteristic and abnormal noises around the plant.

A separate panel is located in this control room for each boiler and each turbine including each house generator. In addition, there are miscellaneous mechanical instruments and controls on another long panel. In all, there about 100 lin ft of panel for basically mechanical, and about 76 lin ft for basically electrical controls.

Each control room operator is given considerable training in what should be done in emergencies. The men are expected to operate both basically electrical and mechanical controls and, after they have become trained in handling the controls, it is though that seven men per shift can operate the entire station.

There appears now to be a trend towards the single boiler-single turbine installation, which would have considerably reduced the number of instruments and controls.

Details of Plant D Controls

Many interesting arrangements are being tried to obtain most of the advantages of centralized control and yet to hold initial costs to a minimum. Figure 9—Plant D shows such an arrangement, which has a separate electrical control room. This is the operating floor plan of a plant addition consisting of two 850-psi, 900-F, 40,000-kw preferred-standard

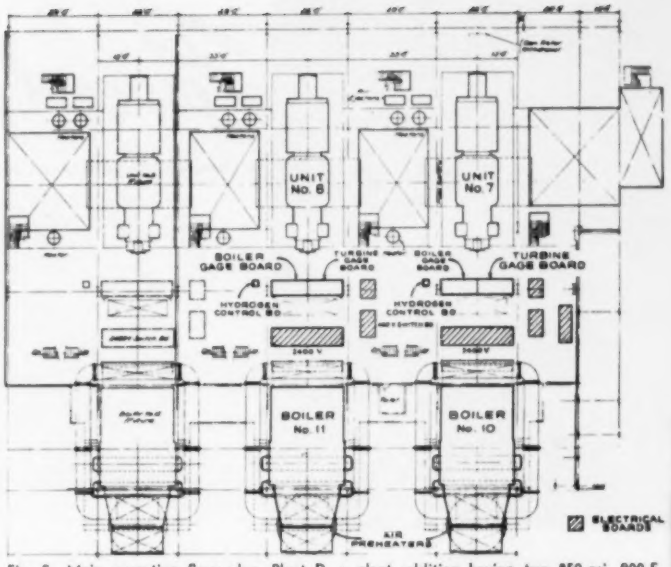


Fig. 5. Main operating floor plan, Plant D, a plant addition having two 850-psi, 900-F, 40,000-kw turbine generators and two oil-and-gas-fired boilers

turbine generators. The plant is oil-and-gas-fired.

The boiler and turbine panels have been located together for each unit and the main panels have been simplified by placing historical or efficiency instruments on other panels, and locating only the instruments and controls necessary for start-run-stop operation at the central point. For each unit this centralized boiler-turbine board is about 24 ft long. Many indicating gages have been combined in multipointer type dials like multipointer draft gages that have decreased the length of the panels.

A bench-board type of panel was investigated for this application, but it was found to require more building space, as it required a mezzanine below the board for initial installation of pipes and wires, and for maintenance of the instruments and controls.

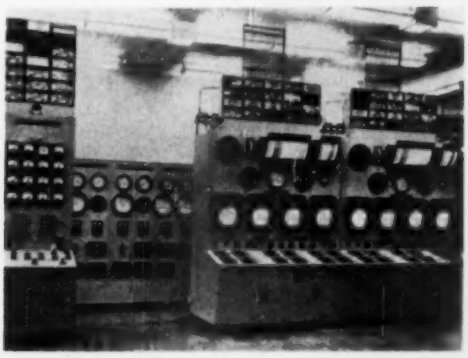
When the first unit of Plant D starts initial operation, it is expected that only three men per shift will be added to operate the gas-fired boiler, the turbine generator and their auxiliaries, one of whom will be immobilized at the central steam control board and the other will circulate throughout the station. A few months later, when the second unit goes into service, one more man per shift will be added, making a total of four. No additional operators will be required in the electrical control room. For starts and stops, a man probably will be called from the other section of the plant, or the station watch engineer will assist.

How Centralized Controls May Be Worked Out

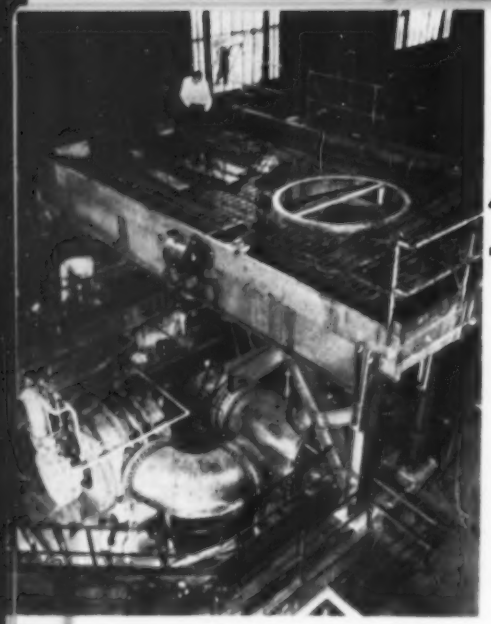
In conclusion, the writer believes that for the initial unit in a new station that has no local distribution, the electrical control room and the boiler and turbine gage boards may be centrally located. However, as more units are added, it appears more convenient to have a separate electri-

(Continued on page 85)

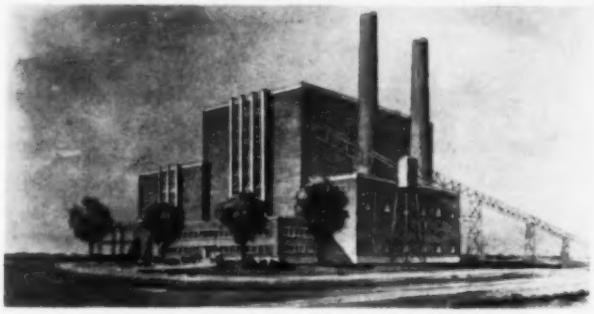
Fig. 6. (Below) General view of control room, Plant C
Fig. 7. (Right) View of boiler control boards, Plant C



Power Generation

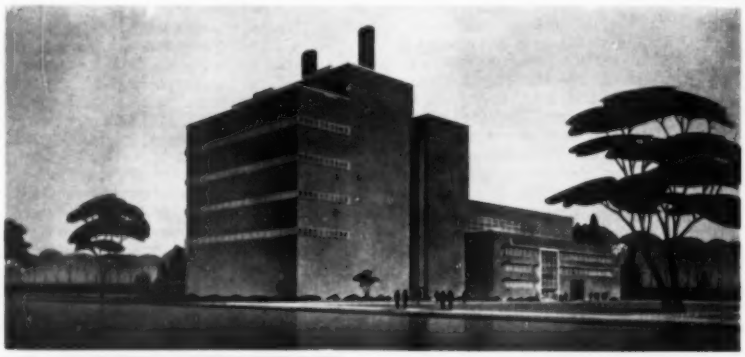


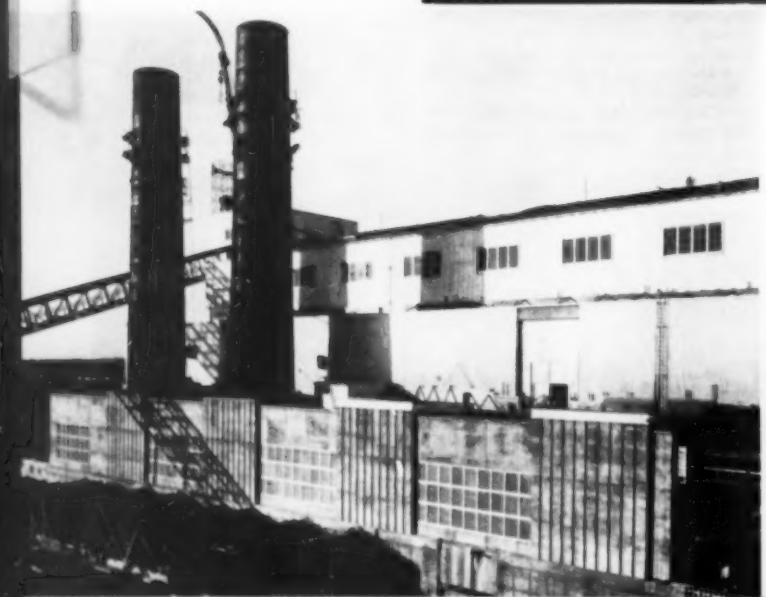
(Above)—Pittsburgh's new flood-proof waterworks pump, a DeLaval 100-mgd vertical pump, single stage, 237 rpm, total design head 58 ft, driven by a 1250-hp motor, being installed by Dravo Corp. workmen at Ross Pumping Station on Allegheny River. Reinforced concrete pump platform is above highest flood level ever reached at station



(Above)—Architect's drawing of Toronto Steam Generating Station, under construction by The Hydro-Electric Power Commission of Ontario. Two initial units; first a 25-60 cycle convertible C. A. Parsons Co. turbine-generator, rated 75,000 to 90,000 kw; second a 60-cycle, 80,000-kw Parsons unit; and two Babcock & Wilcox and Goldie-McCulloch 850,000-lb-per-hr boilers. Stone & Webster Engineering Corp. is consultant

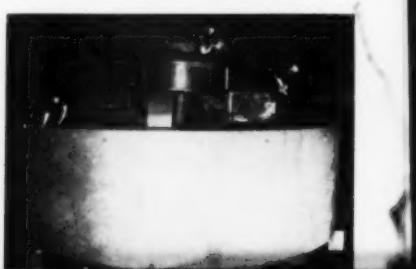
(Right)—Architect's drawing of Windsor Generating Station of The Hydro-Electric Power Commission of Ontario, now under construction on the Detroit River near Windsor, Ontario. Two 60,000-kw initial units; English Electric Co. turbine generators, and two Babcock & Wilcox and Goldie-McCulloch 650,000 lb-per-hr steam generating units. H. G. Acres and Co. is consulting engineer



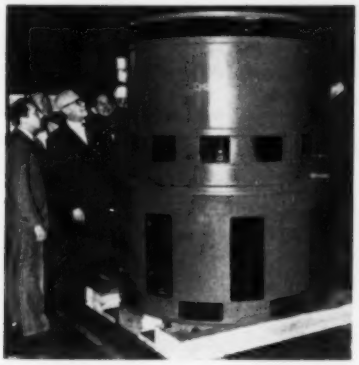


(Left)—Here's how new Ridgeland Station of Commonwealth Edison Co., Chicago, Ill. appeared in January, 1950; construction work now at peak. Initial installation consists of one 150,000-kw steam turbine generator and two steam generating units, fired by cyclone furnaces, generating steam at 1800 psi, 1050 F. First unit scheduled for operation fall 1950; construction under way for second 150,000-kw unit scheduled for service late 1951. One of many Ridgeland features is building of architectural concrete and special insulated aluminum exterior

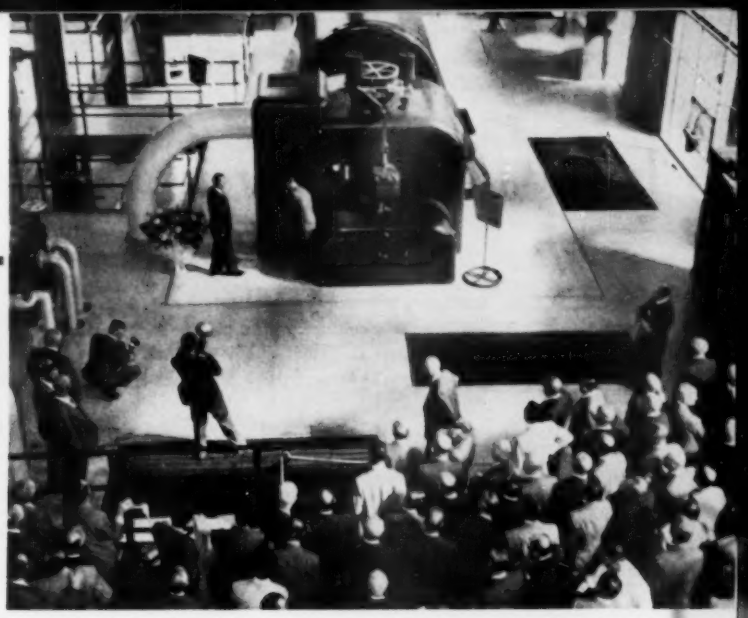
(Below)—One of two 65,000-hp GE synchronous motors shipped to Grand Coulee pumping plant for driving 1600-cfs pumps (See Power Plant Engineering, March, 1946)



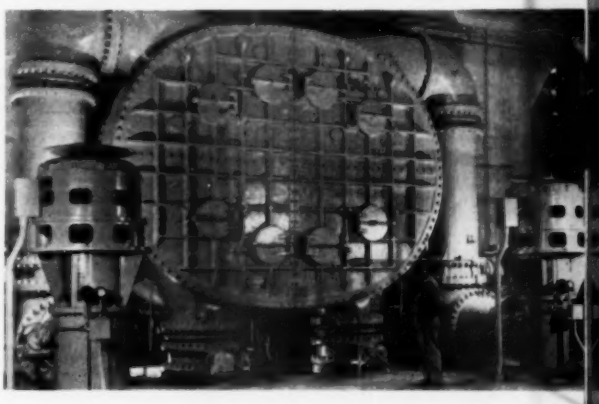
NEWS REEL



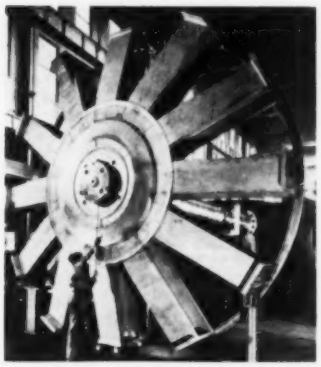
(Above)—Inspecting, in Electric Machinery Mfg. Co. shops, the first adjustable-speed, vertical synchronous-motor-magnetic-drive unit ever built for coupling to a pump, are officials of manufacturer and of City of Philadelphia, Pa., which has ordered four of them for storm water system. Each adjustable speed unit rated at 400 hp, 514 rpm; synchronous motor above magnetic drive



(Above)—At Ripley Steam Electric Generating Station of Kansas Gas & Electric Co., located at Wichita, Kansas, Governor Frank Carlson cut a ribbon and opened throttle on new 30,000-kw turbine generator, before many officials and guests at open house ceremonies on October 14, 1949. President Gill of KG & E watches and assists the governor

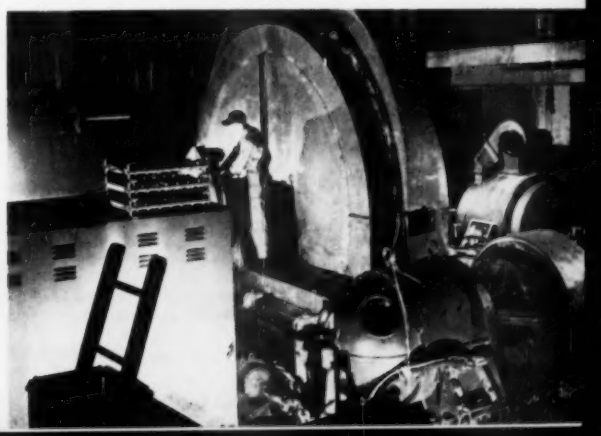


(Right)—Allis-Chalmers surface condenser and vertical circulating pumps, powered by 250-hp, 587-rpm vertical motors, in a Midwestern power plant

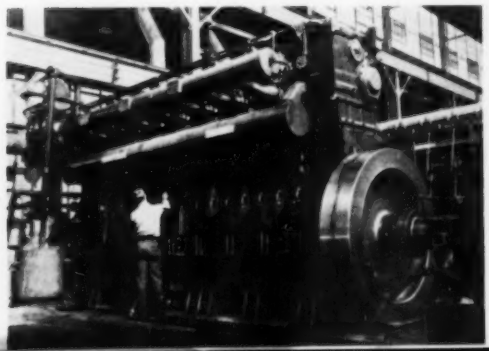


(Left)—Rotor spider fitted on shaft for 28,000-kva, 0.9-pf, 13.8-kv, 100-rpm vertical Allis-Chalmers hydroelectric generator

(Below)—Being prepared for test is modified Kraemer drive for Pennsylvania State College water tunnel. It consists of Allis-Chalmers 2000-hp ANY motor, constant-speed m-g set, variable-speed m-g set and Regulex



(Below)—Making final adjustments on Superior 1440-hp dual-fuel four-cycle Diesel engine before shipment to sewage treatment plant of Department of Public Service, Columbus, Ohio. It will burn gas produced from sewage sludge or natural gas and fuel oil in any proportion from 10 per cent through 100 per cent



Ignition Baffle Improves Single-Retort Stoker Performance

Ignition baffle applied to single-retort underfeed stoker on 178-hp boiler . . . Increases output by 40 to 50 per cent . . . Eliminates smoke, reduces fly ash, increases CO_2 several per cent, reduces labor . . . Cost $200 to install on one boiler . . . May be applied to new or existing installations

By T. S. SPICER[1], R. J. GRACE[2] and C. C. WRIGHT[3]

USE OF ignition baffles or refractory arches is one of the simplest and most effective means of improving the performance of single-retort stokers. One of the outstanding advantages of these baffles is the fact that they may be used with either existing or new installations.

Single-retort underfeed stokers have been marketed since the turn of the century and lead all the other types in the number of units in use. The annual coal tonnage consumed on this type of equipment is considerable and its importance to the solid fuels industry cannot be overemphasized. Moreover, the single-retort stoker is most generally used in applications where oil and gas fuels are most competitive.

It is, therefore, the coal industry's first line of defense where the markets are most vulnerable. While this fact has always been true, the recent high wage level for the firemen has greatly contributed to the operating cost of the small boiler plant, and any improvement that will reduce labor requirements or increase efficiency is important.

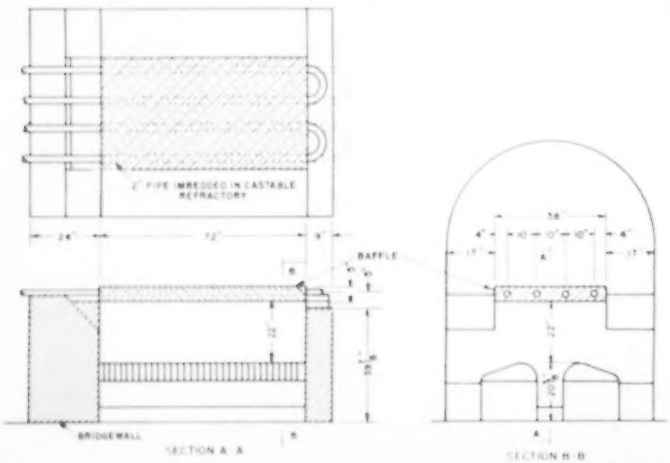
Research work at the Coal Combustion Laboratory of The Pennsylvania State College has led to the discovery that the use of refractory arches over single-retort stokers improves their performance. This work was discussed by the authors at the October 1949 ASME-AIM & ME meeting at French Lick. It has been in progress since 1943 and many approaches to the problem have been tried in an effort to improve the operation.

The refractory arch or baffle seems to be one of the simplest, and yet most effective, means of attaining this end. Perhaps one of the outstanding advantages is the fact that these devices may be used with either existing or new installations.

How Baffle Is Built

These flat refractory baffles are located directly over the center of the retort and extend from the front wall to the bridge wall, as shown in the accompanying illustration. They may be suspended at a height of 19 in. to 27 in. above the level of the firebars, depending upon the size of the machine. The width of the baffle represents approximately 50 per cent of the inside firebox width. The baffle may be 4 in. to 6 in. thick and is supported by 2 in. pipes, which are cooled by circulating water from the feedwater sump. Make-up water may also be used to cool these units, or the supporting units may be directly connected to the circulation of the boiler water. The refractory part of the baffle is made from a castable material, such as Plicast No. 30 or equivalent. Prefired refractory shapes may also be used.

When burning many of the Pennsylvania bituminous coals, particularly those with high percentages of the finer sizes, in boilers with water-cooled walls, it is often difficult to ignite and burn the coal over the retort section. Thus a black center fuel bed results, which is unreactive and reduces the stoker and boiler output. To carry the load and improve the combustion efficiency, it is necessary for the firemen to work the beds manually at frequent intervals. This periodic disturbance of the bed leads to loss of efficiency and objectionable smoke and fly-ash emissions.



Plan and cross-section of furnace under one of two 178-hp heating boilers, showing how ignition baffles were installed

Baffle in Use in Heating Plant Improves Stoker Operation

Use in one of twin 178-hp firetube boiler units at The Pennsylvania State College Nittany Dormitory Heating Plant during the 1948-1949 heating season showed the following advantages from the use of the baffle:

1. Elimination of the black fuel bed over the retort.
2. Increase in the output of the stoker boiler unit by 40 to 50 per cent.
3. Reduction of manual labor to a minimum.
4. Elimination of the periodic smoke discharge resulting from disturbing the bed.

[1] Associate Professor of Fuel Technology and Supervisor of Coal Combustion Laboratory.
[2] Assistant Professor of Fuel Technology.
[3] Professor and Head of Department of Fuel Technology.
All Pennsylvania State College, State College, Pa.

5. Increase of combustion efficiency. The CO_2 content of combustion products was increased several per cent because less excess air was required.
6. Increase of boiler efficiency by 4.0 per cent although burning at higher rates. The temperature of the boiler exit gases remained practically the same.
7. Fly-ash and carryover to boiler tubes was less.

Costs of Installation

Cost of the baffle will depend upon the size and conditions. The college installation was made at an approximate cost of $200, which includes the water circulator, pipes, refractory and labor. Over 1000 tons of coal have been burned by the baffle-equipped stoker and it appears to be good for at least another year of operation. Even if the refractory (cost of material $50) had to be replaced once a year, the user claims it would still be a good investment. Firemen are completely sold on the use of the baffle although they had their doubts when the installation was made.

While coal from the Pennsylvania bituminous seams was used in this work the authors feel that their findings will apply to the coals of many other areas.

Detailed data on the costs and performance of Nittany Dormitory Heating Plant were given in a paper, Small Coal-Fired Central Heating Plant Pays Dividends, by T. S. Spicer in *Utilization*, February, 1948; while the combination with this plant of the Coal Combustion Laboratory is detailed in another paper, Combustion Research Facilities Expanded at Penn State by C. C. Wright, in *Utilization*, June, 1949.

The two stokers, on one of which the above ignition arches have been used, are identical 6 by 6 ft Skelly stokers supplied by Combustion Engineering-Superheater, Inc., installed under two identical National Radiator Co. boilers, each rated at 178 hp.

These two units are metered and controlled independently so that either may be operated under any desired test conditions, either alone, in parallel with the other or in parallel with laboratory test units installed in the adjacent laboratory.

Steam from the plant is delivered at 8 to 9 psig to distribution mains serving the dormitory development, which covers about 18 acres of ground.

Because of draft limitations in the heating plant, the authors have not yet been able to explore the high stoker ratings many operators enjoy with good coals and ample draft. We have reached the 100 per cent rating of the boiler with the baffle but could not do so without it. In other words, the 50 per cent increase noted above was accomplished with difficult-to-burn coals that offered stubborn resistance to ignition.

Our work indicates that higher fuel burning rates in pounds of coal per square foot per hour, will mean that the baffle should be located at a higher point over the grate bars. Besides, the over-all width of the arch may be decreased somewhat. For installations with burning rates of 20 lb per sq ft per hr, the height of the arch may be depth of bed plus 15 in. to 18 in. clearance.

The above is really a digest of the work to date, for at the time of writing we were not able to furnish data on completion of the test work. The paper in its final form will be submitted to the Societies concerned.

SOUTH MEADOW

(Continued from page 67)

liquid thrown into the furnace at full load will cause this detector to make nearly a full scale reading with a visual and sound alarm. The other detector is a Chemical Detector and has a chart coated with yellow selenium sulphide. A continuous sample of warm flue gas is diverted against this chart and when mercury vapor is present it will react with the sulphide and turn it black dependent upon the amount of mercury present. A photoelectric cell will sound an alarm when the chart starts to turn black. Less than 1 oz per minute simulated leak gives a definite indication.

Other instruments indicate the mercury return flow to the boiler, the superheated steam output, the feed water flow to the condenser boilers and the non-condensable discharged from the Kinney air removal pump. The level in the mercury boiler is measured at two points and recorded, and in addition the mercury level in the shaft seal pump tank is recorded. The various mercury and steam pressures are indicated and recorded as well as the condenser boiler vacuum. Flue gas temperatures throughout the unit are recorded as well as the combustion air, feedwater and superheated steam temperatures. The majority of the instruments and the control boards were supplied by the Bailey Meter Co.

Operation

As previously mentioned, the fire was lighted under the new boiler on January 2, 1949 and continued until full load, 15,000 kw. on the mercury turbine, was reached and held for several hours on January 11, 1949. The unit was then shut down for a general inspection and the cleaning of the sump, flash tank and various mercury coolers. The greatest amount of dirt was found after the first full load operation of the unit due to the purging of oxides, rust and dirt from the boiler by the mercury treatment. A second run was made between January 19, 1949 and January 28, 1949. The operation of the major equipment during these two runs was satisfactory, and after a few changes in some of the auxiliaries, the unit was accepted by the customer at the start of its third operating period. This period was for the entire month of February, twenty-eight consecutive days at full loads. The results of this period are tabulated in Table I.

Table I. Operation 15,000 Kw Mercury Unit, February, 1949

Pounds oil burned	12,281,169
Pounds steam generated at 260 psig and 700 FTT	126,118,000
Kwhr Gross output from mercury Turbine generator	10,048,000
Kwhr gross generated from steam	11,387,000
Kwhr total auxiliary usage	565,000
Kwhr net total unit output	20,870,000
Fuel rate—lb oil per net Kwhr	0.588
Heat rate Btu per net Kwhr	10,200

Following this run the unit was started the first part of March with steam being generated in the condenser boilers at 410 psig instead of 310 psig used during previous runs. This has proven equally satisfactory.

The fuel savings from the operation of this mercury unit in place of the high heat rate steam equipment previously used is in excess of 100 tons per day or 500 barrels of fuel oil. Those familiar with present fuel costs may readily estimate the dollar savings. Such figures are phenomenal and well worth investigating.

Output figures since the unit was started on January 2, 1949 to June 15, 1949 are listed in Table II.

Table II—Output data, Jan. 2 to June 15, 1949

Lb steam generated	543,970,000
Kwhr gross output mercury turbine generator	42,138,000
Kwhr equivalent from steam generated	49,411,000
Kwhr Station auxiliaries	2,407,000
Kwhr total net output	89,142,000
Running hours	3078
Period hours	3981

Since the unit was placed in regular service by the customer on February 1, 1949, it has been on the line 2870 hr out of 3240 elapsed hours to June 15, 1949. This gives an availability factor of 88.6 per cent to date.

The American Society of Mechanical Engineers and the Association of Casualty and Surety Companies as administrative sponsors for Sectional Committee A90 announce that the American Standard Safety Code for Manlifts, A90.1-1949 was approved as an American Standard on December 20, 1949.

Interested engineers may obtain copies of this Safety Code by writing to the American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.

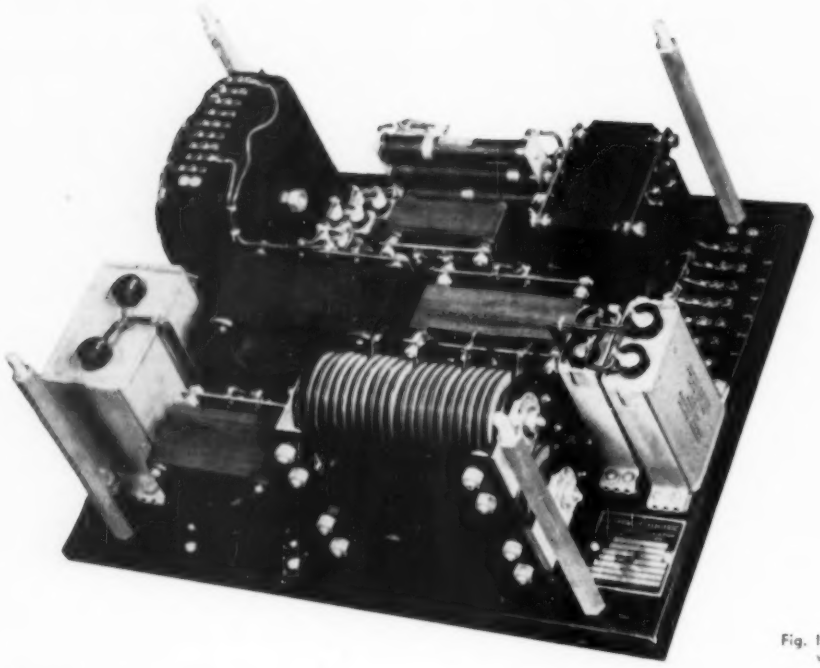


Fig. 1. A typical magnetic voltage regulator

Maintenance of Static Magnetic Regulators

By W. A. HUNTER,

Control Engineering Division
General Electric Company, Schenectady, N. Y.

STATIC MAGNETIC REGULATORS are a relatively new type of regulating equipment. They first became generally available for common regulating applications roughly five years ago, and their use has steadily increased so that they are rapidly gaining an important position in the regulating field. In a few cases they have already replaced well established electro-mechanical and static electronic types of regulators. Consequently, it is probable that it will soon be necessary for maintenance personnel to be as familiar with static magnetic regulators as they are with the older and better known devices which they now service.

Currently, the most important use for this new type of regulator is in regulating the terminal voltage of alternating current generators. Static magnetic regulators have been applied to generators of all sizes up to some of the largest constructed. They are also used to regulate the terminal voltage of synchronous condensers, inverters, and frequency changers. In their capacity as voltage regulators, they have been installed in power plants operated by public utilities, manufacturing concerns, and railroads, as well as in ships and railway passenger cars. At present, they are appearing as regulators for induction heating generators, and portable engine-driven machines. Static magnetic regulators are widely employed to regulate the load of large turbine driven generators, the power factor of synchronous motors, the speed of direct current motors, and the current delivered by direct-current generators.

Their name, static magnetic, accurately describes the unusual design features of this type of regulator. The term static is derived from the fact that all of the regulator components are stationary; the term magnetic is used to indicate that performance of the regulator is largely based upon the characteristics of magnetic components. Static magnetic regulators consist of transformers, reactors, resistors, capacitors, and metallic rectifiers, which are interconnected in electrical circuits to provide a regulating function. A typical voltage regulator is shown in the accompanying illustration. Static magnetic regulators are frequently associated with amplidynes, which are a special type of direct current generator having unusually high amplification ratios and rapid speeds of response. They are also used with or may include amplistats, or magnetic amplifiers, and it is expected that this association will become increasingly significant in the future. Because of the absence of moving parts, and the use of components which are simple, rugged, and long-lived, static magnetic regulators are extremely reliable, and

require only a minimum of maintenance. As a result, they are frequently neglected by maintenance personnel who are obliged to inspect them regularly to make adjustments, provide lubrication, or replace worn parts. Such neglect can result in failure of the regulator, with possible damage to the equipment with which it is associated. Therefore, even though their maintenance may consist of little more than brief and infrequent inspections, static magnetic regulators should be included in regular maintenance schedules if they are to give long life and provide trouble-free operation.

Normal Maintenance

Normal maintenance of static magnetic regulators consists essentially of visual inspection. This inspection may be made at regular intervals, and in no case should a period in excess of six months be allowed to elapse between inspections. At each inspection it should be ascertained that all wiring connections are tight, that the regulator components are not overheating as evidenced by abnormally high external temperature or damage to insulation, that grounds are not present in the regulator circuits except where required, and that the regulator is clean and free from all evidence of moisture. Where the regulator is subjected to vibration, the secureness of mounting screws and supports should be checked. If the condition of the regulator is not satisfactory in these respects it should be removed from service before corrective action is taken by maintenance personnel. Loose connections and mounting screws should be tightened, and components which are in an unsatisfactory condition must be replaced. If the regulator is dirty, it should be carefully cleaned; dry compressed air supplied at reduced pressure is generally satisfactory for this purpose. Grounds must be located and eliminated. If evidence of moisture is present, as indicated by rust, water, or condensation, immediate steps must be taken to correct this condition. In cases where condensation of moisture within the regulator is indicated, it may be necessary to improve ventilation or to remove the regulator to a location where less moisture is present.

Static magnetic regulators are usually equipped with rheostats or variable transformers for adjusting purposes. The sliding contacts of these devices should be inspected to make certain that they are in good condition, and that oxides are not present on the contact surfaces which will cause high contact resistance. Where necessary, contact surfaces may be cleaned with crocus cloth, after which they should be wiped with a clean lint-free cloth moistened with a very small amount of carbon tetrachloride. Contact brushes may be reseated, if required, with crocus cloth; all residue resulting from the seating operation must be carefully wiped away. Lubrication of the shafts and bearings of rheostats and variable transformers is not generally required, and should be attempted only where specifically recommended.

Electrolytic capacitors are frequently used in stabilizing and filtering circuits of static magnetic regulators. They will age even though the regulator is not in service, and since they are subject to failure after several years of life, it is recommended that they be replaced every three to five years. Such arbitrary replacement is, however, seldom mandatory, since serious capacitor aging will usually produce unsatisfactory regulator performance, thereby automatically indicating when replacement is required.

In cases where reliability is of the utmost importance, a spare regulator may be provided for use in the event of failure of a normal equipment. Wherever possible spare regulators should be operated regularly to keep them in good condition, and to make certain that they are ready for service in an emergency. They should be used for several hours at least once a year, and more frequently if they are in a damp location. Care should be exercised when regulators including selenium rectifiers are energized after an unusually long period of inactivity, since operation may be erratic for several minutes until rectifier performance has become normal.

In order to obtain optimum performance of a regulator, and to protect against the possibility of damage to the regulator from external causes, it is important that equipment associated with the regulator be properly maintained. Associated equipment may include generators, exciters, and prime mover speed governors. Rotating machine field and armature circuits to which the regulator is connected must be kept free of grounds. Exciter commutators, alternator collector rings, and their associated brush rigging must be kept in good condition to insure that the regulator will have proper control of machine circuits. System voltages and alternating current fre-

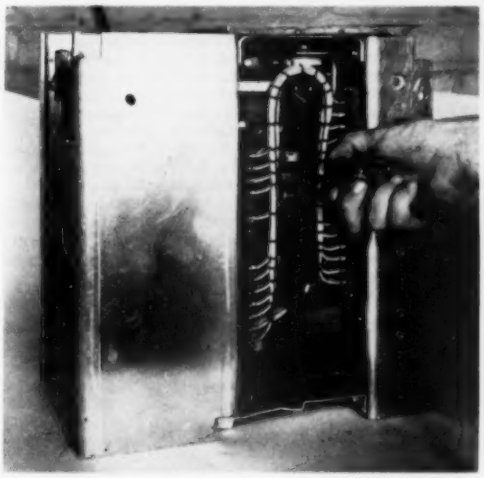


Fig. 2. Use dry compressed air at reduced pressure to keep regulator clean

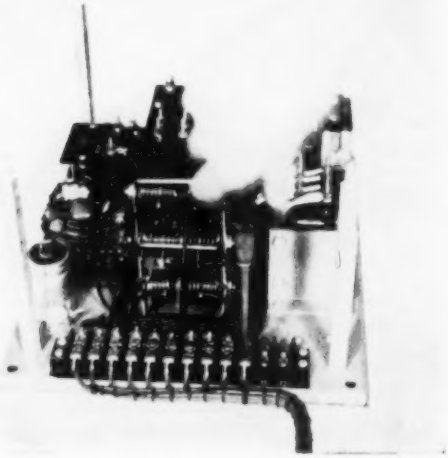


Fig. 3. Keep all connections tight. Mounting screws and supports should be checked

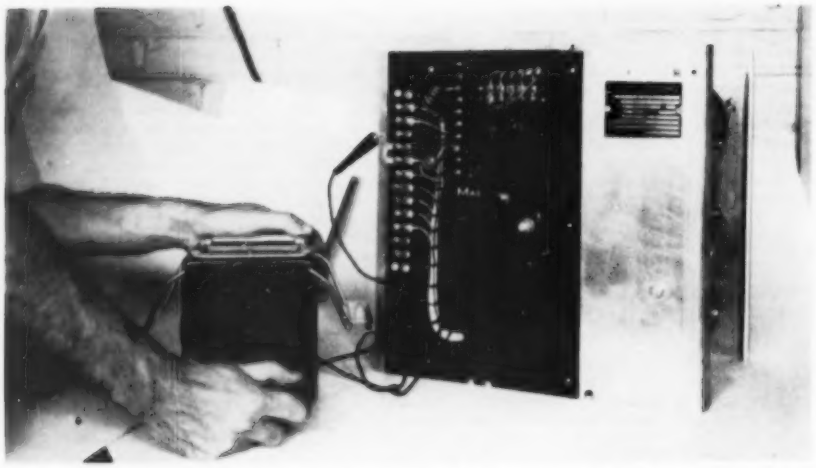


Fig. 4. Use a Megger to test for grounds

quencies should be measured to determine that they fall within the limits for which the regulator was designed.

Failure

Failure in service of static magnetic regulators may result from two principle causes. These are failure through ageing of components, and failure because of abnormal operating conditions. Regulator failures resulting from component ageing should be infrequent, consequently when repeated failures occur, regulator operating conditions should be carefully investigated to determine if they are causing the difficulty. When a damaged regulator has been removed from service, it is usually quite difficult to determine by inspection the true cause of the failure. This is particularly difficult since the failure of one component, through ageing or abnormal operating conditions, will frequently result in the failure of other components, making it almost impossible to determine which component failed first.

Failure of transformers and reactors as a result of ageing is usually due to deterioration of winding insulation. Under normal circumstances, failures due to this cause should not be experienced until the regulator has provided many years of satisfactory service. Ageing of metallic rectifiers may also cause failure resulting from a gradual breaking down of the barrier layer between the rectifier plates. Again, however, this type of failure should not occur until the regulator has reached an advanced age. Metallic rectifiers of the selenium type may deteriorate if they are stored for long periods of time without being placed in service. This type of deterioration is usually not serious because its effects are generally offset when the rectifiers are placed in service. Electrolytic capacitors gradually dry out whether the capacitors are in storage or in service, so that after several years they may fail, or possess unsatisfactory characteristics.

Ordinary ageing of regulator components is greatly accelerated by abnormal operating conditions such as moisture, or ambient temperatures which are above the value for which the regulator is rated. Metallic rectifiers must be sharply derated with increases in ambient temperature, consequently they may fail quite rapidly if subjected to temperatures which are well above the rated value. Operation of regulators at voltages and frequencies which are outside the limits for which the regulator was designed may result in overloading of regulator components, and consequent failure. Component overloads may also be caused by grounds in the regulator or in associated equipment, which result in the flow of large currents through the regulator circuits. Grounds in associated equipment and abnormal system voltages and frequencies may be transient in character, so that they

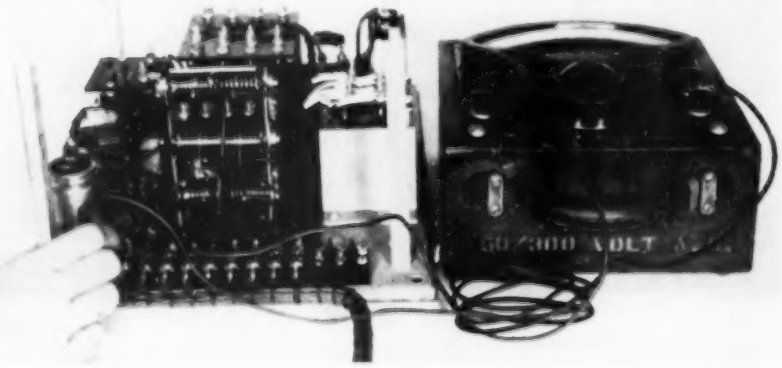


Fig. 5. Measure circuit voltage to make certain that they are within limits for which the regulator was designed

are difficult to locate and establish as the cause for failure.

A damaged regulator must be carefully inspected to make certain that all components in an unsatisfactory operating condition are discovered. Damage to magnetic components is usually indicated by burned, charred, or blistered insulation, and by low insulation resistance between the various component windings or between component windings and their magnetic core. Damage to metallic rectifiers is commonly signified by darkening or burning of the material on the rectifier plates, adjacent to the plate contact surfaces. In general, it is necessary to make a capacity test of oil-filled and electrolytic capacitors to determine if they are in a satisfactory operating condition.

Repair

Damaged components of a regulator which has failed should be replaced with equivalent components obtained from the regulator manufacturer. After all new components have been installed, circuit connections should be checked to ascertain that they are secure and correct. Variable resistors which have been replaced must be adjusted to proper values. All regulator circuits should then be tested for grounds.

It is usually desirable to test a repaired regulator before returning it to service. In many cases this can be satisfactorily accomplished by connecting the regulator to a separate source of power while leaving the regulator output circuits disconnected. Where a separate source of power of the proper voltage and frequency is not available, it may be possible to energize the regulator from the circuits to which it is usually connected, while operating the system which the regulator normally controls by manual means. Where neither of these procedures can be followed, it may be necessary to connect the regulator to its associated equipment in the usual manner, and then to operate this equipment under carefully controlled and safe conditions.

When the regulator is first energized, it should be closely watched to determine that the operating temperatures of all components do not exceed normal values. Where information is available, circuit voltages should be checked in accordance with specific instructions applying to the particular equipment involved. If overheating does not appear after the regulator has been energized for approximately 10 or 20 minutes, it is usually safe to operate the regulator with its associated equipment. Regulator circuit adjustments should then be made in accordance with applicable instructions. When adjustments are complete, the system and equipment controlled by the regulator should be operated in the normal manner to ascertain that regulator performance is satisfactory.

The maintenance required by a static magnetic regulator will depend upon its complexity and the service to which it is subjected. Large and complicated regulators will need more attention then small, simple units. Regulators which must provide maximum reliability, or which are subjected to operating conditions involving unusual vibration or abnormal temperature should be given more maintenance attention than those which do not operate under these handicaps. In all cases, maintenance personnel should familiarize themselves with the construction and operation of the regulators which they must service in order that they may provide intelligent care, and act quickly in case of emergency. Furthermore, adequate testing equipment and instruments must be available if their efforts are to be successful. The performance records of equipment now in service have demonstrated that static magnetic regulators will provide excellent performance and maximum reliability with a minimum of maintenance, if this maintenance is regular, thorough, and properly related to the regulator design and application.

LETTERS

TO THE EDITORS

(Continued from page 53)

some means available to avoid them. Of course, provision of the controls advocated by Mr. Bell at the inception of the plant design would obviate the need for such means.

It remains, however, to insure the availability of standby equipment by the means described in the article. Furthermore, the extreme wide fluctuations between base load and night load still leave us with the problem of pump operation in an extremely unfavorable range of capacities. Use of variable speed devices, such as hydraulic couplings, might alleviate this problem wherever the application of such drives can be justified.

In this connection, the author suggests that strict dollar and cents evaluation is not the only proof of justification, various intangible factors being worthy of equal consideration."

Harrison, N. J. I. J. KARASSICK

ADDITIVES

I AM THE chief engineer at a large printing concern here. I have been reading your magazine for many years.

Several months back you published some material on fuel oil additives and ran some letters on that subject from the readers. I was very much interested in this information because I have been experimenting with the use of oil treatment. Why did you stop this series? I would like to see more articles like that, because most engineers are interested in the subject.

I, for one, am "sold" on using oil solvent. My equipment and steady operating conditions allow me to make some pretty close comparison checks and I have made them with and without oil treatment.

We have two Titusville 300 hp 2-pass fire-tube boilers and run them one at a time. Believe it or not, when using oil treatment I can run a boiler for four months, seven days a week, without once punching the flues; and at the end of the run remove less than a gallon of soot.

Without treatment, we have to punch flues weekly and get 10 times as much soot in a week without treatment as in four months with it. Also, with treatment, we never get carbon on the burner or in the firebox, and the strainers stay clean.

In the last two years, I have burned over 2,000,000 gal of Bunker C and there isn't a bit of sludge in those tanks. Our oil additive also did a good job of emulsifying water, of which we had a lot at one time.

I know that lots of engineers are "anti" on oil solvent and I suppose that, as in anything else, there are good and bad products. But I wouldn't hesitate to recommend the solvent we use to any fellow engineer. I've been in this business for 20 years and think I know labor saving and economy when I see it. Personally, I would as soon operate without boiler water treatment as without oil treatment.

Give us some more stories on oil solvent and let me express my regard for POWER GENERATION, which is always interesting and helpful.

Chicago, Ill. HENRY O. NELSON

Discussion of additives started in the February, 1949 issue with an article by Paul F. Schmidt. This was discussed in this department by Readers Hope, Senko and others, and Mr. Schmidt presented more data in the April, 1949 issue.

We did not stop the discussion; it just stopped itself. We certainly welcome any specific additional data on types and uses of additives, especially the sort of practical data from a user as given by Mr. Nelson.

HOW COULD the water shortage in the New York-New Jersey area possibly affect the water supply in Venezuela? Well, for about ten years, Standard Oil Co. (New Jersey) has been exporting water from a Northern New Jersey reservoir for the use of its personnel at Aruba, the big oil refining center off the north Venezuelan coast. The shipments, made by tankers returning to Venezuela after having delivered Venezuela crude at Bayonne and Bayway, averaged about 200,000 gallons a day up to a short time ago. Then, because of the need for saving water in the New York area, the shipments were cut by 20 per cent.

New Turbine Room for B. F. Nelson Mfg. Co.

The new turbine room for the B. F. Nelson Mfg. Co. in Minneapolis, Minn., constitutes an excellent example of modern industrial power plant design. The initial installation of a 3000-kw extraction-condensing turbine generator unit and a 750-kw machine of similar design will satisfy all present power requirements but provision is made for the future installation of another 3000-kw unit if necessary. The boiler plant of this company was described in the October 1948 issue

By **J. H. PEEBLES**, Chief Engineer, B. F. Nelson Mfg. Co., Minneapolis, Minn.,

and

H. P. HARRIS, Chief Engineer, Frederick L. Smith, New York, N. Y.

ABOUT A YEAR and a half ago[1] we described in these pages the new boiler plant at the B. F. Nelson Mfg. Co. in Minneapolis. This new boiler plant, consisting of two 85,000 lb per hr boilers built for operation at 450 psi, replaced an existing plant which was obsolete.

As explained in this article, plans also included the construction of a new turbine room so that the purchase of electricity could be dispensed with entirely. The construction of this turbine room has now been completed. Since it is one of the finest examples of small industrial plant turbine room construction that we have been privileged to see in recent years, it will be described in some detail here. Like the boiler plant, the turbine room was designed by and constructed under the supervision of Frederick L. Smith, consulting engineers of New York, N. Y.

The general character of this turbine room can be seen in the accompanying photographs but monochrome pictures cannot do this room justice because it is unusually colorful. The walls are lined with buff colored ceramic tile from the floor to the ceiling. The floor is red tile laid with black cement. The ceiling is buff while the equipment —the turbine-generating units and auxiliary equipment is painted a medium light green. The main electrical switchboard is also light buff enamel.

The whole scheme is extremely pleasing to the eye and since the equipment is generously spaced with ample room between units the design is conducive to good operation and morale among the operators.

Two Turbine Generating Units in Initial Installation

Two condensing extraction turbine generating units are installed at the present time. One of these is a 3000-kw unit and the other a 750-kw machine. Normally, the 3000-kw machine is capable of carrying the load and the small machine is only for standby use.

As explained in the article on the boiler plant in the October 1948 issue the B. F. Nelson Mfg. Co. involves a boxboard mill, a felt mill, a roofing mill, asphalt felt saturator, a box factory and a print shop. This type of operation naturally requires considerable quantities of low and medium pressure steam and hot water, hence the extraction turbines. Still in operation is a large twin Corliss engine belted through a line shaft to beaters and jordans. Plans call for the retirement of this engine and electrification of the paper mill and when this plan is carried out additional generating capacity will be required. This future need has been taken into consideration in the design of the turbine room. As will be noted from the accompanying plan of the turbine room, space is provided for another 3000-kw unit at the other end of the room; indeed, the footing for this machine is already installed. Thus, ultimately the turbine room will have a 3000-kw unit at each end with the 750-kw standby unit in the center.

Both generating units are General Electric Co. machines, generating 3-phase, 60-cycle current at 4000 v. Steam pressure at the throttles is 400 psi and the temperature 650 F. While these machines operate condensing; steam is extracted at approximately 40 psi for process work. Extraction steam is supplemented by steam from the boilers through reducing valves if necessary.

The condensers are C. H. Wheeler surface type condensers, the one for the 3000-kw turbine having 2250 sq ft of surface and the one for the 750-kw unit, 700 sq ft. Both condensers are of the 2-pass type, the large unit having divided water boxes so that one half can be cleaned while the other half remains in operation. Cooling water is circulated through the condensers by two C. H. Wheeler circulating pumps.

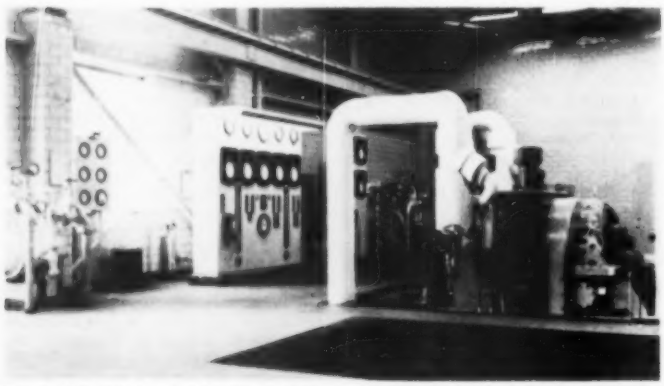


Fig. 1. General view in the new turbine room showing the 750-kw turbine unit in the right foreground, the turbine control panel in the center and one of the steam-jet air ejectors at the extreme left

[1] October, 1948.

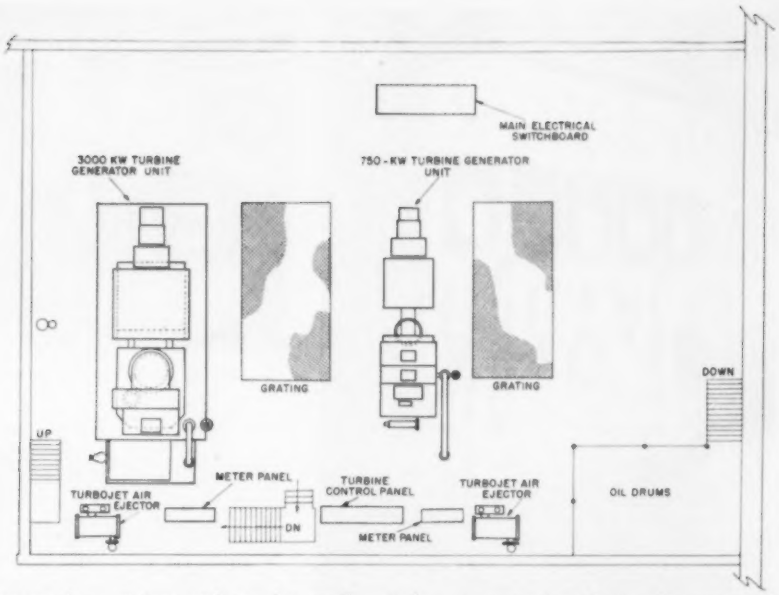


Fig. 2. Plan of the turbine room showing the arrangement of equipment

These circulating pumps are installed in a pump house at the intake on the river and they are controlled from the main turbine control board on the operating floor by means of push buttons. The amount of water through the condenser is further under the control of the operators through the agency of airloaded butterfly valves in the condenser circulating water lines equipped with position indicators.

Each condenser is served by two condensate pumps, C. H. Wheeler units, and C. H. Wheeler twin bank, two-stage steam jet air ejectors with inter and after condensers. The latter are installed on the operating floor opposite the steam ends of the turbine generators. On the large unit the condensate pumps are driven by 220/440 v Louis Allis motors and on the small unit by Fairbanks Morse motors.

Figure 2 shows a plan of the turbine room floor showing the arrangement of equipment. The turbine control board, it will be noted, is approximately in the center of the room, convenient to the throttle valves of both turbines. A view of this board is shown in Fig. 8. The five flow meters and recorders are Bailey meters measuring steam

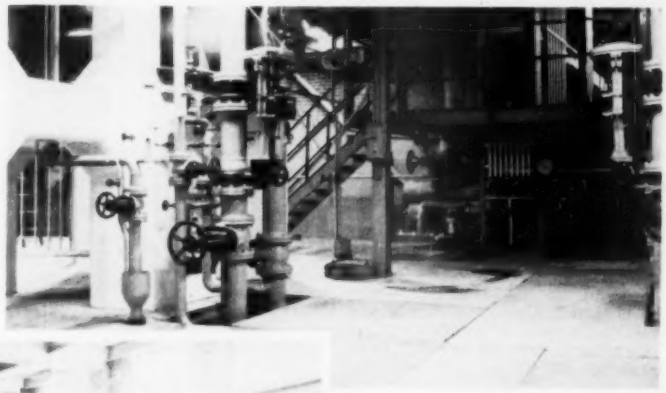


Fig. 3. (Above) A view of the condenser floor showing the condenser for the 750-kw generating unit at the left

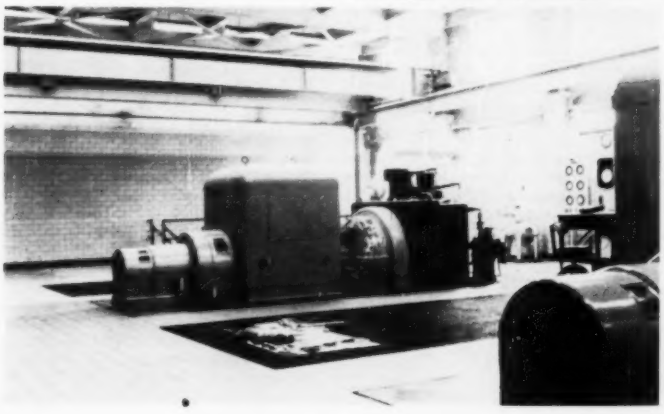


Fig. 4. (Left) Another general view in the turbine room showing the 750-kw unit and the 15-ton turbine room crane. Note fluorescent lighting

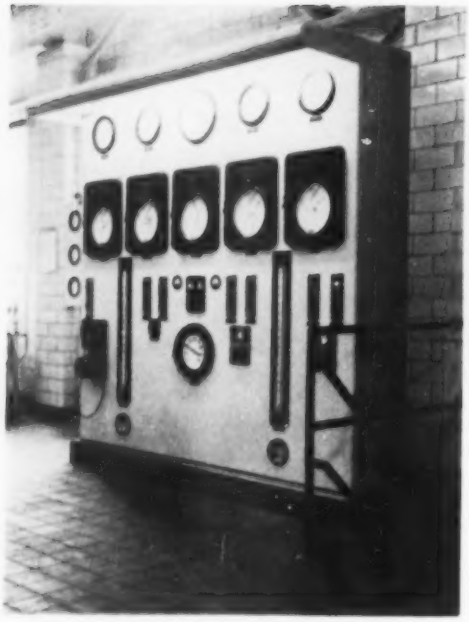


Fig. 5. The turbine control panel

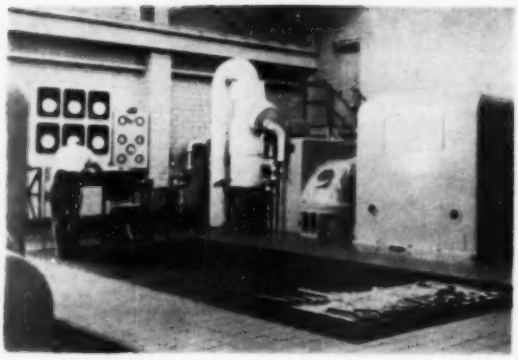


Fig. 6. A view of the 3000-kw turbine generating unit

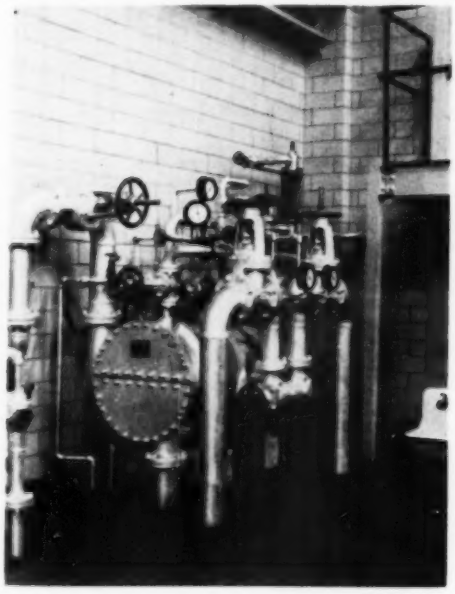


Fig. 7. A close-up view of the steam-jet air ejector for the 3000-kw unit. These units are installed on the operating floor opposite the steam end of the turbine units

pressure and flow on each unit, extraction steam to the mill and the center meter is on the desuperheater control. Two mercury column vacuum gages measure the exhaust conditions on the two units. These columns are maintained in accurate calibration by means of a mercury barometer located on the wall close by. In addition, the board contains the push button controls for the circulating water and condensate pumps, the vacuum pumps and the controls for the air loading valves on the circulating water lines, as well as other indicating meters. The board is finished in a light color and lighted by fluorescent lamps in a canopy which forms an integral part of the panel. In addition to this main control board, there are two other instrument panels, one on each side for the respective turbine generators. The panels mount the indicating meters measuring the inlet, first stage, extraction and exhaust pressures on the turbines, water pressures, and vacuum gages.

The instrument equipment in this plant is unusually complete and exceptionally well installed. Figure 10 is a view of some of the instrument piping in the basement. It is easily accessible and simple to trace in case of trouble.

The main electrical control board is placed along the opposite wall from the turbine control board. It consists of 7 panels and a swinging bracket carrying the volt meters, synchroscope and frequency meter. This board is a Westinghouse board, fully enclosed, with a few GE instruments. Looking at the board as in Fig. 8, the left hand panel is the generator control panel for the 3000-kw unit. Next is the exciter panel for that unit carrying the Silverstat controlling the exciter voltage. The next is a relay panel while the fourth and fifth are two feeder panels. The sixth panel is the panel for the 750-kw generator and the last, the exciter panel for that unit. Like the turbine control panel, the electrical control board is finished in light colored enamel finish. All the circuit breakers controlled by this board are located on the floor below. These are all of the air break type.

The lighting of this turbine plant is extremely well done. Fluorescent lighting is used throughout, both on the operating floor and in the basement. In the turbine room there are 30 lamps, arranged in five rows of six each. These are hung from the ceiling which is approximately 20 ft above the floor. The construction of this ceiling is of interest, since it is hung from the roof trusses of the floor above. When the turbine room was built, space above it was needed for rag storage. Hence this form of construction was adopted. While it provided the necessary storage space, it limited somewhat the natural lighting of the turbine room so high level fluorescent lighting was used.

Another unusual feature of this turbine room is the ventilating system. This system is based on the heat developed by the 3000-kw generating unit. In the design of the system it was estimated that some

637,500 Btu would have to be removed every hour. In order to remove this heat it was necessary to introduce some 30,000 cfm of air at a temperature of 20 degrees below the maximum desired ambient temperature for the machines, which was taken as 95 F. This air would have to be reduced to approximately 75 F to maintain proper temperature conditions in the turbine room.

To accomplish this a capillary air washer was installed. This reduces the temperature of the air from the maximum 95 deg dry bulb and 75 deg wet bulb to approximately 75 deg wet bulb during the summer months. Two axial flow type exhaust fans, each with a capacity of 10,000 cfm are installed in the wall of the turbine room above the electrical control board.

The ventilating equipment consists of the following units: 1 A & R Capillary washer, 30,000 cfm, consisting of housing, sprays, tank, capillary filter and eliminator; 1 Ingersoll Rand close coupled pump, 120 gpm driven by 3-hp motor; 1 American Blower; 1 Set of recirculating dampers with modulating control and thermostat for winter use; 1 15-hp GE Motor, starter and push button control; 2 42-in. Axiflo type exhaust fans, each with a capacity of 10,000 cfm and each driven by a ¾-hp motor.

Conclusion

This turbine room, together with the boiler plant installed the year before, now supplies all the steam and electric power requirements of the B. F. Nelson plant. It is simple in design and its roominess and attractive architectural features are conducive to good operation and maintenance on the part of the operators. For handling equipment in case of overhaul, a 15-ton Pawling and Harnischfeger electrically operated crane is provided.

For protection of the generator in case of electrical fire, a Walter Kidde CO_2 fire extinguishing system is provided. This is designed so as to function automatically in case of fire and is installed so as to introduce the gas directly into the generator air cooling system.

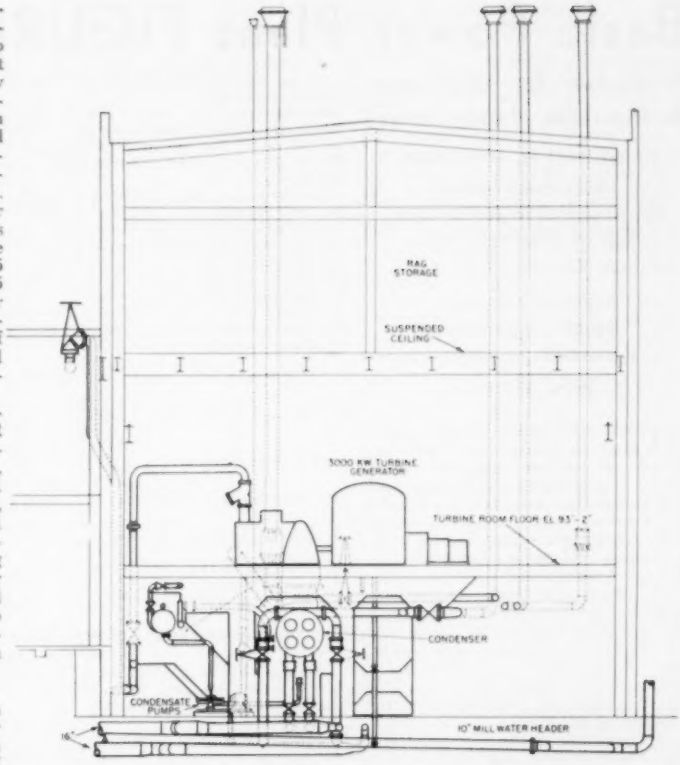


Fig. 9. Elevation of the turbine room showing the building construction

Fig. 10. (Right) A view in the basement showing the instrument piping

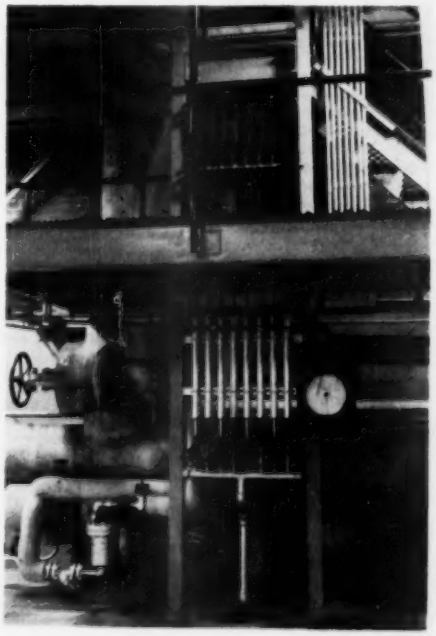
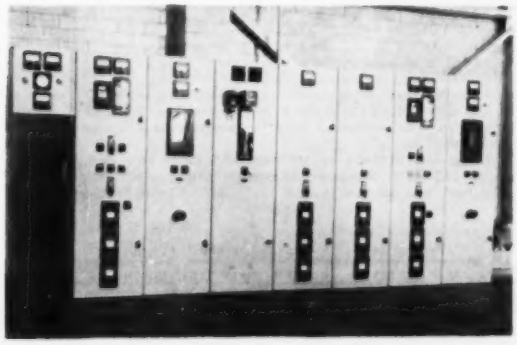


Fig. 8. (Below) The main electric control board



Basic Power Plant FIGURING

A Review for Old-Timers
A Must for Young-Timers

By WILLIAM H. ENGELMAN,
Mechanical Engineer
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City of Cleveland, Ohio

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Boiler Calculations: Actual Evaporation, Equivalent Evaporation, Boiler Efficiency

HERE ARE some typical problems in boiler calculations, which all power engineers must know how to make. They are not all the calculations required but are the fundamental ones, subject to many refinements depending on the completeness and accuracy needed for the purpose in hand.

To work out these calculations, you will need to refer to the Steam Tables (Thermodynamic Properties of Steam, by Keenan and Keyes; John Wiley & Sons, Inc.) from which the enthalpy values are taken. This is the standard reference for the properties of steam.

Explanation of the principles and reasoning behind the equations is given in Elementary Steam Power Engineering by MacNaughton (John Wiley & Sons, Inc.) 3rd Edition, especially in Chapter 12.

However, for the most extreme accuracy in determining the efficiency as well as accounting for all the losses, it is necessary to follow the procedures given in the Test Code for Stationary Steam Generating Units of the American Society of Mechanical Engineers. Every power engineer should have a copy of this test code and should check frequently to make sure he has the latest edition of it. Copies may be obtained for 75 cents each from the American Society of Mechanical Engineers, 29 West 39th Street, New York City.

The test code, result of years of work and revision by leading power engineers, gives definite rules for obtaining data in boiler tests, for recording them in proper form, and for calculating a complete heat balance for units burning various fuels. These code methods, representing the best experience of the field, are accepted as standard by power engineers everywhere.

However, in the calculations given here, these questions do not enter. It must be assumed that the values given have been obtained by some acceptable method. The object of this discussion is to show how they may be used once they are obtained.

Problem 1:—The following data were obtained during the test on a coal-fired B. & W. Stirling type boiler:
Steam pressure 211.4 psig; degrees F superheat 161.8; barometer 29.75 in.; feedwater temperature 196.5 F; water evaporated 43,200 lb; weight of coal as fired, 5520 lb; ash and refuse, 570 lb; combustible in ash 9 per cent; moisture in coal as fired 4.5 per cent; Btu per lb dry coal 13,100; duration of test, 6 hr.

Calculate:

a. Steam pressure abs. $= 211.4 + (29.75 \times 0.491) = 226.0$ psia.
b. Total steam temp. $= 392.2 + 161.8 = 554.0$ F.
c. Enthalpy per lb of steam above 32 F $= 1,295.8$ Btu.
Heat in feedwater, 196.5 — 32 $= 164.5$ Btu.
d. Heat furnished by boiler per lb of steam $= 1,131.3$ Btu.
e. Factor of evaporation $= 1,131.3 \div 970.3 = 1.16593$
f. Equivalent evaporation $= 43,200 \times 1.16593 = 50,368$ lb in 6 hr
g. Pounds of dry coal $= 5,520\ (1.0 - 0.045) = 5,271.6$ lb
h. Actual evaporation $= 43,200 \div 5,520 = 7.8261$ lb per lb coal as fired.
i. Equivalent evaporation $= 50,368 \div 5,271.6 = 9.5546$ lb per lb dry coal.

j. Efficiency $= \dfrac{9.5546 \times 970.3}{13,100} = 0.7077$ or 70.77 per cent

k. Efficiency (coal as fired) $= \dfrac{43,200 \times 1,131.3}{5,520 \times 12,510} = 70.77$ per cent

l. Efficiency (dry coal) $= \dfrac{43,200 \times 1,131.3}{5,271.6 \times 13,100} = 70.77$ per cent

m. Boiler horsepower developed $= \dfrac{7,200 \times 1,131.3}{33,475} = 243.3$

n. Btu in refuse $= \dfrac{14,600 \times \%\ C \text{ in refuse}}{100} = \dfrac{14,600 \times 9}{100} = 1,314$ Btu.

o. Efficiency of boiler and furnace correcting for item n. $=$
$$\frac{7,200 \times 1,131.3}{(920 \times 12,510) - (95 \times 1,314)} = 0.7155 \text{ or } 71.55 \text{ per cent.}$$

Comparison of Boiler Calculations by the Heating Surface Method and by the Btu Method

Problem 2:—A boiler with 3,000 sq ft of heating surface evaporates 300,000 lb of water in 8 hr from a feedwater temperature of 211 F into dry saturated steam at 125.3 psig. The barometer reading is 30 in. Hg.

Calculate:

a. Pounds of steam generated per hour.
b. Enthalpy furnished by the boiler, Btu per pound.
c. The boiler horsepower developed. (970.3 × 34.5 is 33,475 Btu per hr or 1 bhp.)
d. The Boiler Manufacturer's Rating. (10 sq ft heating surface is 1 bhp.)
e. Square feet of heating surface used per boiler horsepower developed.
f. The per cent of rating at which the boiler operates.
g. Pounds of water evaporated per hour per square foot of heating surface.
h. Factor of evaporation from and at 212 F.
i. Equivalent evaporation, pounds per hour.
j. Equivalent evaporation, pounds per square foot per hour.

Values for steam are taken from Keenan & Keyes Thermodynamic Properties of Steam.
Absolute steam pressure $= 125.3 + 14.7 = 140$ psia.
Btu per lb of steam at 100% quality $= 1,193.0$
Btu per lb of feedwater 211 — 32 $= 179.0$
Btu per lb furnished by boiler $= 1,014.0$

Solution:

a. $300,000 \div 8 = 37,500$ lbs per hr.
b. 1,014 Btu per lb
c. Boiler Horsepower $= \dfrac{37,500 \times 1,014}{33,475} = 1,136$
d. Standard rating $= 3,000 \div 10 = 300$ boiler hp. at 100 per cent.
e. $3,000 \div 1,136 = 2.641$ sq ft heating surface to produce 1 bhp.
f. Boiler operates at $1,136 \div 300 = 378.65$ per cent.
g. $37,500 \div 3,000 = 12.5$ lb water per sq ft per hr.
h. Factor of evaporation $= 1,014 \div 970.3 = 1.04504$
i. Equivalent evaporation $= 37,500 \times 1.04504 = 39,189$ lb per hr.
j. $39,189 \div 3000 = 13.063$ lb of water.
Checking with Item f: $13.063 \div 3.45 = 3.7865$

NOTE: Manufacturers base their ratings of boiler horsepower on a definite amount of water-heating surface. The rating of all stationary boilers is based on 10 sq ft of heating surface per boiler horsepower. This method is used for convenience only, and is known as the "Manufacturer's Rating."
The commercial boiler horsepower is the evaporation of 34.5 lb of water per hr from a feedwater temperature of 212 F. at standard atmospheric pressure, into dry saturated steam: this is the heat output, and is equal to $34.5 \times 970.3 = 33,475$ Btu per hr.

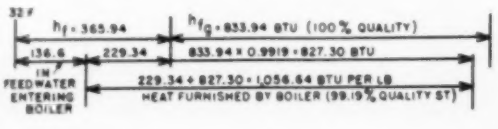

32 F
h_f = 365.94
h_{fg} = 833.94 BTU (100% QUALITY)
136.6
229.34
833.94 × 0.9919 = 827.30 BTU
IN FEEDWATER ENTERING BOILER
229.34 + 827.30 = 1,056.64 BTU PER LB
HEAT FURNISHED BY BOILER (99.19% QUALITY ST)

Diagram for Problem 3, showing to approximate scale the heat added by the steam generating unit to produce 1 lb of steam

Problem 3:—A test on a B & W cross-drum marine boiler gave the following data:

Steam pressure	209.9 psig	Quality of steam	99.19 per cent
Barometer	30 in. Hg	Feedwater temp.	168.6 F
Fuel oil used	5943 lb	Fuel Heat Value	19,291 Btu per lb
Duration of test	2 hr	Total water Evaporated	74,898 lb

Find: a. Equivalent evaporation from and at 212 F.
b. Actual evaporation, pounds per hour.
c. Heat output Btu per hour.
d. Factor of evaporation.
e. Boiler horsepower developed (1 bhp = 34.5 × 970.3 = 33,475 Btu per hr)
f. Overall efficiency.

From Keenan & Keyes Steam Tables, the Btu per lb of steam are:

Heat of the liquid h_f at 224.6 psia. = 365.94 Btu
Heat of evaporation h_{fg} at 224.6 psia = 833.94 and 833.94 × 0.9919 = 827.30 Btu
(see diagram below) Total 1193.24 Btu
Heat in feedwater above 32 F = 168.6 — 32 = 136.60 Btu
Net heat per pound of steam supplied by boiler = 1056.64 Btu

a. $W_e = \dfrac{74{,}898 \times 1056.64}{2 \times 970.3} = 40{,}780$ lb per hour equivalent evaporation

b. Actual evaporation = 74,898 ÷ 2 = 37,449 lb per hr.

c. Heat output = 37,449 × 1056.64 = 39,569,000 Btu

d. Factor of evaporation = 1056.64 ÷ 970.3 = 1.0890

e. Boiler horsepower = 39,569,000 ÷ 33,475 = 1182 bhp

f. Overall efficiency $= \dfrac{\text{output}}{\text{input}} = \dfrac{\text{Total Btu in steam generated}}{\text{lb fuel oil per hr} \times \text{Btu per hr}}$

$= \dfrac{39{,}569\,000}{2971.6 \times 19{,}291} = 0.6903 = 69.03$ per cent

Equivalent Evaporation per Pound of Dry Coal at Various Efficiencies.

Boiler Eff'y. %	B.T.U. per pound of dry Coal							
	11,500	11,600	11,700	11,800	11 900	12,000	12,100	12,200
65	7.7038	7.7708	7.8378	7.9048	7.9717	8.0386	8.1057	8.1727
66	7.8223	7.8903	7.9583	8.0264	8.0944	8.1622	8.2304	8.2984
67	7.9408	8.0098	8.0789	8.1480	8.2170	8.2859	8.3551	8.4242
68	8.0594	8.1295	8.1995	8.2696	8.3397	8.4096	8.4798	8.5500
69	8.1779	8.2490	8.3201	8.3912	8.4623	8.5333	8.6045	8.6756
70	8.2964	8.3685	8.4407	8.5128	8.5849	8.6569	8.7292	8.8014
71	8.4149	8.4880	8.5613	8.6345	8.7076	8.7806	8.8539	8.9271
72	8.5334	8.6076	8.6818	8.7561	8.8302	8.9042	8.9786	9.0528
73	8.6520	8.7272	8.8024	8.8777	8.9529	9.0280	9.1033	9.1786
74	8.7705	8.8467	8.9230	8.9993	9.0755	9.1516	9.2280	9.3043
75	8.8890	8.9662	9.0436	9.1209	9.1982	9.2753	9.3527	9.4301
76	9.0075	9.0858	9.1642	9.2425	9.3208	9.3989	9.4774	9.5558
	12,300	12,400	12,500	12,600	12,700	12,800	12,900	13,000
65	8.2397	8.3067	8.3737	8.4406	8.5077	8.5747	8.6417	8.7087
66	8.3665	8.4345	8.5025	8.5705	8.6385	8.7066	8.7746	8.8427
67	8.4933	8.5623	8.6313	8.7004	8.7694	8.8385	8.9076	8.9767
68	8.6200	8.6900	8.7602	8.8302	8.9003	8.9704	9.0405	9.1106
69	8.7468	8.8179	8.8890	8.9601	9.0312	9.1023	9.1735	9.2446
70	8.8736	8.9456	9.0178	9.0900	9.1621	9.2343	9.3064	9.3786
71	9.0003	9.0734	9.1466	9.2198	9.2930	9.3662	9.4394	9.5126
72	9.1271	9.2012	9.2755	9.3496	9.4239	9.4981	9.5723	9.6466
73	9.2538	9.3290	9.4043	9.4795	9.5548	9.6300	9.7053	9.7805
74	9.3806	9.4568	9.5331	9.6093	9.6856	9.7619	9.8382	9.9145
75	9.5074	9.5846	9.6620	9.7392	9.8165	9.8939	9.9712	10.049
76	9.6341	9.7124	9.7908	9.8690	9.9474	10.026	10.104	10.182
	13,100	13,200	13,300	13,400	13,500	13,600	13,700	13,800
65	8.7757	8.8426	8.9096	8.9766	9.0436	9.1106	9.1775	9.2446
66	8.9107	8.9786	9.0467	9.1147	9.1827	9.2508	9.3187	9.3868
67	9.0457	9.1147	9.1838	9.2528	9.3218	9.3909	9.4600	9.5290
68	9.1807	9.2507	9.3208	9.3909	9.4610	9.5311	9.6011	9.6712
69	9.3157	9.3868	9.4579	9.5290	9.6001	9.6712	9.7423	9.8135
70	9.4507	9.5228	9.5950	9.6671	9.7392	9.8114	9.8835	9.9557
71	9.5857	9.6588	9.7320	9.8052	9.8784	9.9516	10.025	10.098
72	9.7207	9.7949	9.8691	9.9433	10.018	10.092	10.166	10.240
73	9.8557	9.9309	10.006	10.081	10.157	10.232	10.307	10.382
74	9.9907	10.067	10.143	10.220	10.296	10.372	10.448	10.525
75	10.126	10.203	10.280	10.358	10.435	10.512	10.590	10.667
76	10.261	10.339	10.417	10.496	10.574	10.652	10.731	10.809

$$\frac{\text{B.T.U. per lb per dry coal} \times \text{Efficiency}}{970.3} = \frac{13{,}000 \times 0.70}{970.3} = 9.3786 \text{ lb (table)}$$

CENTRALIZED CONTROLS

(Continued from page 71)

cal control room and then to have an immobilized central steam board operator for each main turbine-boiler unit, with the required number of auxiliary mobile operators.

An operator or group of operators can care for one turbine-boiler unit and ordinarily do a good job in case of trouble; but if they have more than one to cover, there is a chance that any complication of difficulties may develop into a serious outage.

Many of the advantages of a centralized control room may be gained, and some of the disadvantages eliminated, by have a centralized point for the control of each single boiler-single turbine located between the boiler and turbine at the main operating floor level, with the switchboard in a separate room where the electrical control for several such single boiler-single turbine units and those of the out-going line would be located.

The writer favors this latter idea on the premise that a good operator should be able to control a single boiler-single turbine unit gage board, but that anything more than this, with present-day equipment and controls, does not give adequate care in times of trouble. This one man must have assistance in starting the unit and, when the unit is running, for circulating through the plant. The control board operator should be in close contact with the other operators.

How Reduce Size of Panels

Smaller instruments and controls are needed for basically mechanical operations in order to consolidate the many items required and shorten the panel boards. This might be accomplished by placing the operating mechanism of flowmeter controllers near the equipment controlled and having air loading pressures or electric wires only brought to the centralized control point.

LEADING RESEARCH scientists of United States Steel Corp.'s subsidiary companies have pooled their findings and data on high-temperature steels. The result is a practical new 87-page, illustrated booklet, "Steels for Elevated Temperature Service," available through Carnegie-Illinois Steel Corp., Pittsburgh, for the use of engineers, chemists and metallurgists in the power, transportation and chemical process industries, as well as those interested in the design of jet engines, rockets, and gas turbines.

The booklet opens with a discussion of the general principles of elevated temperature behavior of ferrous metals.

For practical use, the booklet provides both tabular and graphic data on the specific mechanical properties of twenty-one different steels.

Fig. 1. General view of the Colorado Springs Plant showing new addition under construction

Mixed Power In Colorado Springs

Further light on the Pikes Peak power supply described in the August 1949 issue.

By ROBERT M. ORMES

THE POWER supply for Colorado Springs, Colorado, consists of a mixture of steam and hydro generation in curiously shifting proportions.

The shifting proportions are due to the eccentricities of the hydro-electric operation, described in the August, 1949, issue of POWER GENERATION, under the title, "Power from Pikes Peak". Since the hydro power uses the town's water supply, the quantity generated depends on the supply of that water and the rate at which it is used during any given period.

In its early days, hydro plant history read like a civil war. "Why can't we run the water through," the power men wanted to know, "when we need the power?" "And why," replied the water people, "should we run water through your plant at times when we can't use it?"

The intelligence of these questions degenerated. Around 1905 there were periods when the questions were asked with brickbats and answered by little posses who went on stealthy valve-turning missions after dark. Now, power and water are served up under a single administration, and the dual function of the water supply is coordinated as neatly as the weather allows.

The basic limitation on hydro power supply is rain and snowfall in the watershed. There isn't enough of it to keep either of the plants—a 2500 kw high level and a 5000 kw low level plant—running at capacity. If there were enough, then plant capacities would need to be increased to take advantage of higher-than-minimum flow periods.

There is a seasonal peak for water use in the summer, when lawns and gardens require irrigation. Reservoirs at high level are built up during winter and spring months to provide a larger flow for this summer use. Fortunately summer is also the peak for power consumption because at that season a big wave of tourist visitors swells the town's normal population.

The power pattern is not fully predictable, despite this seasonal increase, since seasons themselves vary widely. In a very dry summer, for example, water consumption is high, and power production good since all the water comes from storage reservoirs that feed through both upper and lower power plants. Likewise power production may be high in an excessively wet year, for when the storage system is full, water must be run down hill for want of a place to keep it upstairs. It is usually possible to utilize all high level water for power because the 5000 kw lower plant can handle so much more than is usually fed into it. Only rarely are both of the 2500 kw units running at full capacity and at the same time bypassing some water. It is in a medium wet summer that power production is lower, since town rainfall cuts consumption and high level rainfall goes into storage.

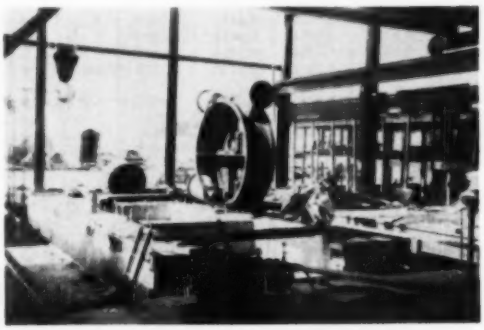


Fig. 2. (Right) The new condenser head ready to be lowered in place

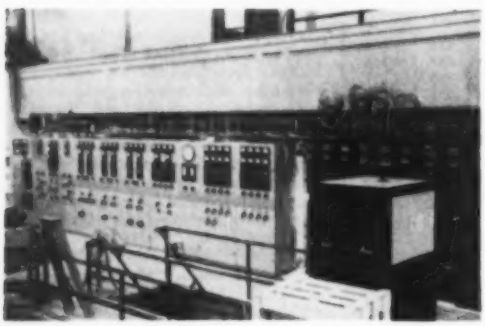


Fig. 3. (Left) The new duplex electrical control board

A still more interesting factor in the hydro power production level is the hour to hour control the engineers apply during the nine months or more of fractional water consumption. In fall, winter and spring, most

of the water needs are supplied by the flow from streams below the high level storage reservoirs. There is a tank 130 ft wide and 10 ft deep which collects this stream water and funnels it into the penstock for the 5000 kw plant. This tank is allowed to fill up during the hours of lowest power consumption. It is held full through the day, when only stream flow is used to generate power. About five pm, when the peak load for power comes in, the tank is opened to drain into the penstock so that the plant's full power capacity can be utilized at that time.

There is a large economy in a plant that can be turned on and tapered off without the inefficiency of heat loss.

It is planned to triple the storage capacity at the level of the 130 ft tank, a move which will increase the elasticity of the power timing plan described.

Besides its contribution to city power, the hydro plant takes care of two suburban circuits and one REA circuit of its own. These circuits have their power load even more heavily accented in summer than is that of the city, and steam plant operators are glad for this sizable lift in summer hydro production. It is a valuable factor in smoothing their peak demand.

While the hydro plants produce power in a very useful way, their proportion of the total output has gradually dropped from a 60 per cent figure of two decades ago to around 20 per cent now. To take care of the rising load, a new 10,000 kw turbine is being added to the two 5000's kw units and two 2500's kw units now in use in the natural-gas-fueled steam plant. Progress on the construction of this plant has been interesting.

First the building's north wall of brick was pulled off and a temporary one substituted. Then there was the excavation and the pouring of basement floors and walls and a turbine foundation. Next the condenser was lowered. Then the steel frame for the building annex went up, and the mezzanine floor was poured to hold various auxiliary apparatus such as the air ejector, air coolers, etc. Next the turbine floor was poured and enough of the roof put on to protect the turbine. The turbine was installed, the condenser lifted into position and piers built to set it on. With the turbine being assembled and installed, the brick walls started up. The final feature of this assembly will be a cooling tower.

The building is fortunately situated on a hillside. While the "ground floor" level is even with the ground at the front of the building, the basement level is even with the ground at the back, 23 ft lower, and can thus have low-level windows.

There is a possibility that more hydro-electric power may be added to the system, since the water supply has been extended to the north slope of Pikes Peak, and if this is done, the power may be used to pump in an additional water supply by way of returning its debt to the water system. All of which adds up to the fact that the war of 1905 is long since over. But that's another story.

Fig. 4. The new condenser being lowered into place by two cranes

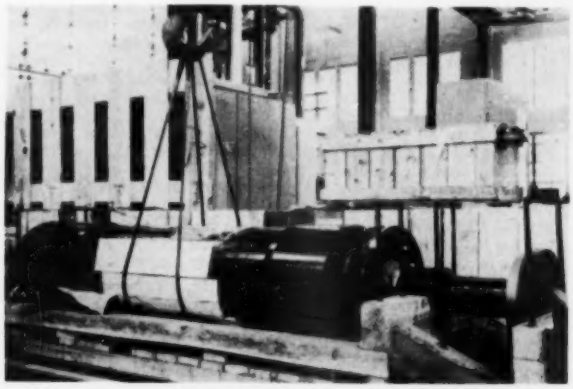


Fig. 5. (Above) The rotor for the new 10,000 kw turbogenerator unit

Fig. 6. (Right) Unloading the rotor from the "lowboy"

Three Thousand Attend AIEE Winter Meeting

Titus LeClair nominated to succeed James Fairman as President of the AIEE at record breaking meeting in New York. Non-technical feature of meeting, addresses by Sir Ernest Benn of Great Britain and Ex-governor Stassen. Dr. Vannevar Bush made life member. Edison Medal presented to K. B. McEachron. Hoover Medal, posthumously, to Dr. Frank B. Jewett

By ANDREW W. KRAMER,
Editor, Power Generation

THE WINTER GENERAL MEETING of the American Institute of Electrical Engineers held at the Statler Hotel in New York City, January 30 to February 3 was attended by almost 3000 electrical engineers from all parts of the United States and Canada. The program consisted essentially of the presentation of some 227 technical papers but was varied by the inclusion of several social events and opportunities for inspection trips to interesting plants in the vicinity of New York.

Among the nontechnical elements of the program was the first general session on Monday afternoon, January 30, where Harold E. Stassen and Sir Ernest Benn of Great Britain addressed the meeting, Sir Ernest's address being delivered by means of an electrical recording. At this meeting also, an honorary life membership in the Institute was presented to Dr. Vannevar Bush, former head of the Office of Scientific Research and Development and now President of Carnegie Institution of Washington.

At a second general session on Wednesday evening, the Hoover Medal was presented posthumously to Dr. Frank B. Jewett who died last November, and the Edison Medal presented to Dr. K. B. McEachron of the General Electric Co. for his work in developing our better understanding of lightning.

Sir Ernest Benn's address, "Why go the way of Britain," was presented as a recording, because, as he said, "Even if my personal circumstances had permitted me to accept your generous invitation to come in person, to talk directly to you, and enjoy a few hours in the society of free men, I should have felt impelled to decline, for I am not prepared to accept the only terms which my Government will allow me to travel. I have, in the past, enjoyed my full share of what I regard as one of the happiest things on earth, the American genius for hospitality. But I have always been able to meet you on more or less level terms. I could, for instance, offer a handful of roses, or a box of candies, at my own expense, to a charming hostess. Now, I can only come to you as a pauper, possessed it is true of a sufficiency of devalued English paper pounds, but absolutely barred from securing, of my own right, the dollars or dimes to spend as I myself would like to do. Being, perhaps, a pig-headed Victorian, having spent three-quarters of a century in another atmosphere, I am not prepared to put myself into this curious and uncomfortable position."

With this introduction the British publisher launched into a vigorous criticism and denunciation of the policies of the British labor government, and at the same time, warned those in the United States who were inclined to the socialistic form of government to learn from the British example. Quoting Shakespeare who said "security is mortals' chiefest enemy," Sir Ernest said, "We have had enough experience of security to know exactly what it means: A technical claim upon salaries or wages, austerity rations bought with Marshall Aid, more and more paper money and less and less of anything to buy. The absence of the natural penalty for failure to do one's duty has reduced output per man, with, of course, glorious exceptions, to the lowest in all our history. Our people have believed the promises of 1945 and have concentrated on their supposed rights and forgotten their responsibilities. . . . I think that you may safely consider that you are very near the end of this painful story.

"There are now a few thinking people among us who do not realize that while it is easy to make *rich* people poor, it is quite another matter to make the *poor* rich."

Ex-governor Stassen's eloquent and ably delivered address touched upon somewhat the same basic theme as Sir Ernest's but was more general in that he considered world conditions as a whole. For the basis of his ideas he drew upon the studies of historian Arnold Toynbee and highly recommended Toynbee's book in which the substance of these studies is presented. In his study of past civilizations, Toynbee had found that the fall of ancient civilizations was not so much a result of decay due to age as it was the absence of challenge. As long as a challenge remained, civilizations persisted but when they became supreme and reduced all opposition to practically

Dr. Vannevar Bush, right, receives an honorary life membership from James Fairman, President of the Institute, in the presence of Harold E. Stassen, former governor of Minnesota and now President of the University of Pennsylvania, who addressed the general session

nothing, a process of dissolution set in.

There was a lesson to be learned from that, said Mr. Stassen, that was applicable to individuals as well as civilizations, and it was in this respect that Mr. Stassen's ideas coincided with Ernest Benn's; under the present system in Great Britain, the absence of the natural penalty for failure to do one's duty has brought with it disastrous consequences. The individual, said Mr. Stassen, should not only be rewarded for his efforts but he should also be penalized for failure to exert himself. Throughout all of nature, life is a struggle and if the necessity for this struggle is removed the consequences are fatal. Thus, for the best interests and the survival of the individual, there should be not only an incentive to work but also there should be a penalty for failure to do so.

In passing, Mr. Stassen referred briefly to Russia. Under the present system in Russia, which, in theory at least, is built along socialistic lines, there is high production with little incentive, at least from our point of view. But, if there is little incentive, the penalties are great. A person who does not want to work or who shirks his duty is not tolerated; he is imprisoned or sent to a labor camp, or even liquidated. "If you want to go the route of obliterating human liberties and putting penalties," said Mr. Stassen, "then you can get a certain limited production — more than under some other systems — but still only a fraction of that under a system in individual initiative, incentive and freedom."

In his acceptance speech at the Edison Medal presentation, Dr. McEachron gave an extremely interesting account of the history of lightning research and the development of lightning protection equipment during the last half century or more.

Lightning arrestors — simple gaps to ground—he pointed out were first used by the telegraph and telephone companies. With the development of electric power systems, similar gaps were used as lightning arrestors but the tendency for the power current to follow the path to ground initiated by the lightning discharge introduced complications. At that time, the arrestors were applied based on the expectation that the transformer strength was greater than the lightning potential allowed by the arrestor. The absurdity of this expectation was subsequently proved but so little was known of lightning voltages or the wave shape of lightning discharges that the idea persisted for some years. When the impulse generator was developed with potentials of a million volts or more, investigators for the first time had a tool by means of which they could produce lightning discharges in the laboratory, but even with this equipment, actual knowledge of wave shape, duration of discharge, etc., was meagre. In the meantime, power systems grew and lightning had become the limiting factor in continuity of service in many systems.

The complexion of the whole problem changed in 1924 with the introduction of the cathode ray oscillograph, which permitted for the first time recording of the volt-time, amper-time, or volt-ampere characteristic of a single transient with a time resolution of fractional parts of millionths of seconds. This tool, said Dr. McEachron, was needed to give impetus to the study of lightning and lightning protection. It was soon applied in laboratory and field investigations, securing data not possible in any other manner.

The year 1924 also saw the introduction of the Klydonograph, and three years later the surge voltage recorder, both instruments designed to record transient voltages through

Dr. K. B. McEachron, General Electric lightning research engineer who received the Edison Medal

the use of Lichtenberg figures. Polarity and frequency of occurrences were also recorded. With these instruments connected to transmission lines, operating companies began to collect data to be correlated with trip-outs, flashovers, and the physical characteristics of the circuits and structures involved.

The impulse generator limitations were removed in 1925 with the use of the Marx circuit which eliminated the use of the high-voltage transformer with its large power supply. By 1930 several lines of investigation had been clearly identified, which included the study of natural lightning effects on transmission lines, effects of wave travel over transmission lines, laboratory tests, and the development of types of lightning arrestors whose characteristics were fixed and predictable. With the development of the Thyrite and the porous block types of lightning arrestor, with cathode ray oscillograms demonstrating their performance, a long step forward was taken in the building of confidence in the arrestor as a protective means. Considerable experience still was required as well as more knowledge before there could be complete confidence in the lightning arrestor to do its job.

The picture was to change very rapidly, however, in the next few years. In the five-year period ending in 1935, over 100 papers had been presented to the Institute by many different members. By this time most of the data needed for the design of the lightning-proof high-voltage line had been obtained. In fact, the design of the 287 kv double-circuit lines completed in 1936 from Hoover Dam to Los Angeles was good enough so that but three interruptions charged to lightning have occurred in the 13 years since the line was built.

Our story, said Dr. McEachron, is now complete with one exception. What are the numbers that belong to lightning itself? How much current, how long does it last, what are the wave shapes and how often do they occur? The problem was to get in series with the lightning stroke itself. So in 1937 the investigation of lightning strokes to the Empire State Building in New York began. Special oscillographs and cameras were used, from which much has been learned about the characteristics of lightning in terms of time, current, as well as data on the mechanism of the lightning stroke itself. Thus, we come to the end of a most remarkable demonstration of an industry solving a very serious limitation in its service to the public in the short space of time of about 15 years through a voluntary mobilization of its engineering personnel and its facilities, once necessary instruments became available.

As usual, the meeting covered the whole vast field of electrical engineering in all its multifarious aspects. In all there were 53 technical sessions and 19 conferences. No attempt will be made here to present even a brief description of the character of these sessions but in this, and future issues, abstracts of certain of the more important papers of interest to power engineers will be printed. In this issue practically the full text of B. C. Mallory's paper on the design and operation of centralized control rooms is given. This paper was one of four, presented at the session on centralized control on Tuesday afternoon. While there have been great advances in the design of control and regulating apparatus, Mr. Mallory said that the picture of operating a steam-electric power station by one man sitting in a small air-conditioned office watching a single dial and twisting a single control handle to solve all operating problems is still only a dream. Present day equipment and controls are not sufficiently trouble-free, even with the best maintenance programs, and are not trusted to operate satisfactorily without adequate attention.

Of interest to one who has followed the development of electronic systems of motor control over the past ten years, was the increased attention given at this meeting to the subject of *large* electronic d-c motor control and electronic excitation for large turbine generators. Heretofore such controls have been considered satisfactory for small motor drives but there has been little application of such systems to large motor drives. At this meeting, however, there were a number of papers indicating the satisfactory application of these electronic systems of control to large motor drives in industry. According to J. A. Johnson, Chief Electrician, Times-Mirror Co., Los Angeles and E. M. Stacey of the General Electric Co. who presented a paper on this subject, at the present time large electronic printing press drives are operating in four metropolitan newspaper plants in this country and equipment for four more publishers is now in process of manufacture or installation.

The question as to the reliability of electronic exciters for large generators brought forth considerable controversial discussion. A number of the older operating men seem to feel that the electronic exciter lacks the reliability of the conventional motor driven or shaft driven exciter, though the latter seem to be subject to considerable trouble. This attitude, however, was refuted by the experience of several of the operating engineers who have used electronic exciters for a number of years. One of the largest electronic exciters ever built, a unit at Springdale station rated at 800 amp, 250-v, in three years of operation has been responsible for no generator outage and by actual test this exciter has an efficiency of 82 per cent. At this same station, the direct-connected conventional exciter has not proved as reliable as the electronic exciter.

Among the inspection trips available one of the most popular was the trip to Sewaren Generating station but another, of particular interest to power station operators was a demonstration of quick start procedure at Waterside Station No. 1, of the Consolidated Edison Company of New York, on Friday morning at 9 o'clock. This involved the starting up of a 60,000 kw, low pressure (200 psi) 1800 rpm generator in 15 minutes. This is standard procedure with the Consolidated Edison Company and not necessarily confined to the low pressure units. The high-pressure topping turbines are started in the same short time. The fundamentals to be observed in quick starting of turbines after overnight shutdowns are to be certain that the spindle is running true within a mil and that the steam inlet temperature is approximately 5 to 100 deg above the steam chest metal temperature. The unit involved was one of two 60,000 kw units installed in 1948 and 49. Thermocouples were installed on one of the units to study the rate of metal temperature change throughout the whole rolling time. As a result of this study the total rolling time was reduced from 1½ hr to 15 min on all atrat-ups where the shutdown time is less than 10 hr. Prior to rolling the unit with steam the auxiliaries are placed in service and a vacuum.

At a meeting of the nominating committee held on Tuesday, January 31, Titus G. LeClair, Assistant Chief Electrical Engineer of the Commonwealth Edison Co. of Chicago was nominated to succeed James Fairman as President of the Institute when the latter's term expires in July of this year.

GROWTH OF PUBLIC SERVICE CO. OF NEW HAMPSHIRE SYSTEM

(Continued from page 61)

renovated, this floating power plant is now operating successfully, using dockage and fuel storage facilities at Portsmouth built for the "Jacona".

Beginning in 1946, a 15,000-kw hydro-plant, the J. Brodie Smith Station, was constructed on the Androscoggin River at Berlin, N. H. The plant was dedicated in 1948.

The third major addition to the company's generating facilities pioneers a new concept in power generation. This is the Schiller Station, a 40,000-kw mercury and steam cycle generating plant at Portsmouth, N. H. Two mercury boilers, each producing 987,000 lb of mercury vapor per hour, two 7,500-kw mercury turbines and one 25,000-kw steam turbine are expected to comprise one of the most efficient fuel-burning plants in the world.

Since its beginning in 1926, Public Service Co. of New Hampshire has increased its production of electric energy from 100 millions of kilowatt hours to approximately 675 millions of kilowatt hours annually. The company's generation, transmission and distribution facilities have constantly been increased to keep pace with this increase in use, according to programs planned years ahead in anticipation of the need, with particular attention paid to the balance of fuel-burning and water-power generating facilities required because of the uncertain water conditions natural to this area.

"——and now that th' plant has switched over to atomic fuel——well, in short, boys, he's taking over your job!!"

Questions and Answers

Q & A—THE POWER ENGINEER'S FORUM—HERE'S HOW IT WORKS

YOU HAVE a question about some detail of power plant operation, maintenance, design. You can't find the answer in your own experience nor in the books. So you write in to our editors. If we know the answer, we send it right back to you. (Maybe we don't know the answer either, but we usually know where to get it for you.)

In any case, we publish your question, signed only with your initials. We do not reveal your identity.

Dozens of engineers write in to us, giving their answers. We forward you copies of the replies as soon as we get them.

You, too, cooperate with other engineers by answering their published questions in the same way.

Then, so far as space permits, we publish those replies as soon as possible, so that everybody will learn what the others know about the problem. We pay well for all answers published. And those who answer get credit for knowing.

Simple, isn't it? And effective? Just ask the power engineer who has tried it!

Engineers who take the trouble to answer your question would appreciate some information from you, transmitted through the Q & A editor, on how their answers helped solve your problem. In doing this, indicate whether or not your comments could be published for the benefit of all readers.

Question No. 454

HOW CALCULATE HEATING COIL FOR OIL STORAGE TANK?

WHAT IS THE method of calculating the size and length of piping or tubing for steam coils necessary to maintain No. 6 fuel oil at 140 to 160 F in various sizes of fuel oil storage tanks, both underground and above ground?

Sheboygan, Wisc. R.H.B.

Question No. 455

WILL ALCOHOL STOP BRINE FOAMING?

WE ARE HAVING TROUBLE with foaming of the brine in our ice cream plant. Several engineers have told me that alcohol will remedy this condition, but I am afraid to try it for fear that it will affect the temperature of the brine. Has anyone used this method of treatment? How can I eliminate the foaming?

Houston, Texas M.C.J.

Question No. 456

CAN HE CONVERT 24-v d-c MOTOR TO RUN ON 110-v a-c?

I WOULD LIKE to convert a 24-v, compound-wound, d-c motor into a 110-v a-c motor, without rewinding it, if that is possible. Will you please tell me how this can be done? The diagram gives all the information I have on this motor.

Las Cruces, N. M. C.D.F.

Question No. 457

HOW DETERMINE MOISTURE IN COAL SAMPLE?

IN OUR POWER PLANT, we have found that the coal sample collected through a standard Sturtevant sampler crusher shows consistently less moisture than samples of the same coal not run through a sampler crusher. This affects the "Btu as received" by as much as 2 per cent.

Have other power engineers discovered and recorded or charted such a difference? If so, what did they do about it? What methods of sampling and testing for moisture in coal do other engineers use?

Pennsylvania R.E.H.

Question No. 458

HOW OFTEN SHOULD WE OVERHAUL OUR DIESEL?

FOR SUPPLYING electric power to our small factory, we have a 300-hp Diesel engine generator set installed new about 3 years ago, and operating an average of 8 hours a day, 5 and 6 days a week, ever since.

This engine has never been shut down for a maintenance overhaul but gives no sign that it needs such an overhaul. The fuel consumption remains the same as it was when the engine was new; and the increase in lubricating oil consumption is so small we think it negligible. But we are wondering whether or not we ought to shut the engine down now and take it all apart to see what condition it's in. Should we do this or should we wait until some signs of trouble appear?

We have been following the discussions in POWER GENERATION and PLANT ENGINEERING, its companion magazine, on preventive maintenance and we know all the arguments about maintaining equipment before it reaches a major breakdown stage. We understand it is perfectly possible that our Diesel cylinders may be grooving or something of that sort, even though there are no outward signs of trouble.

Is there any general practice in overhauling and maintaining Diesel engines? For example, should they be shut down after a given number of hours and all parts inside and out inspected? If so, what should be the approximate number of operating hours between such maintenance periods?

Quincy, Mich. C.D.M.

Answer No. 441

WHO CAN HELP THIS ENGINEER PUMP COLD MOLASSES?

Paugh Commends Worcester

I WOULD like to have a copy of Mr. Worcester's paper on Pumping Viscous Materials, noted at the top of page 81 of the December issue. (*Editor's Note:—Dozens of other readers have asked for it, too.*)

I have had considerable engineer-

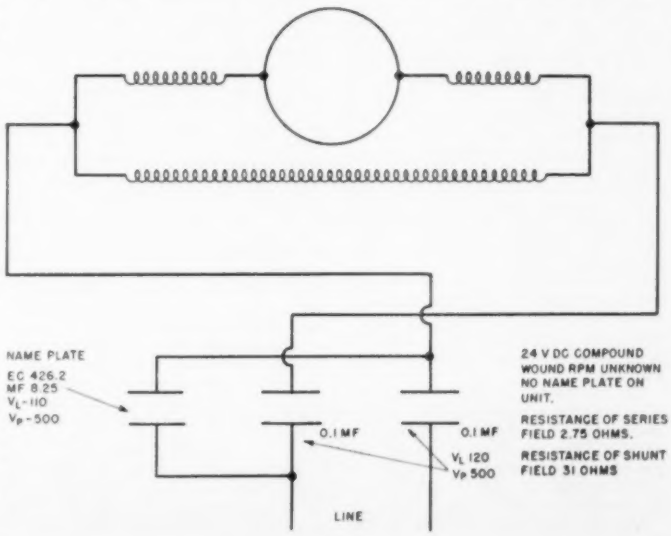


Diagram by C.D.F. showing connections of 24-v motor he wants to convert to 110-v a-c operation

ing experience in this subject and I fully agree with Mr. Worcester's published comments. I can also say that the Kinney Type SD pump is at least equal to any available for this service when selected of ample size and run at low speed.

Also, to economically pump 400 gpm of black strap molasses a distance of 200 ft, a pipe line not smaller than 14 in. should be used.

Baltimore, Md. CHAS. T. PAUGH

Answer No. 450

WHAT CAUSES BURNER TROUBLE AND HIGH DRAFT IN THESE BOILERS?

How Scroggins Cured Similar Trouble

I READ with interest Question No. 450 by C.C.S. about "draft trouble," which causes his natural-gas burners to vibrate and backfire.

Now I'm just a small-time engineer and see many articles in your magazine which make me realize how little I know about engineering; but I would like to relate a similar trouble which I experienced with gas burners and how it was corrected.

In 1941 we completed the construction of a new power plant with two 350-hp and one 150-hp gas-fired water-tube boilers. When the air mixture louvers would get the least bit too wide, the burners would begin to puff like a steam engine coming up a mountain. This puff would vibrate the walls and windows and very nearly burst your ear drums. This would create a dangerous situation, causing the burners to backfire and sometimes puff out.

The contractors and inspectors on the job laid the trouble to the draft. They installed a steam jet in the smoke stack, which increased the draft considerably but did not correct the burner trouble.

After weeks of haggling and experimenting, it was decided that the stack was not high enough, so that is where things were when I inherited the job.

I soon noticed if I would turn off a center burner and put more pressure on the outside burners, so the gas would leave the burner orifices with greater velocity, that the burners did not puff. I then installed manometers on the gas pipes just before they entered the burners, and immediately noticed that when this pressure dropped below ½ lb, the burners began to puff. The immediate trouble was corrected by throttling the center burner enough to hold 10 oz pressure on the outside burners.

On one of my boilers, I then exchanged the size 30 orifices on the burners for a size 40, which are smaller. This enabled me to let the gas out of the burners with a greater velocity, holding near 10 oz or more of pressure on the burner tips.

On the other two boilers, a cost of $30 or $40 was involved to procure the smaller size orifice and for various reasons I couldn't afford it. So, not having the smaller orifices, I removed two orifices from each hole and plugged them with iron cement. We have the Mettler L. P. burners which, in my opinion, are a very good burner. These burners have four orifices to each burner hole. I simply removed the top and bottom orifice in one hole and plugged them, then on the next hole I plugged the two holes on the side. By alternating thus on each burner hole, I was able to raise the pressure at the burner tips enough to eliminate the puffing.

My diagnosis of this trouble was that the burners were OK but were designed for a heavier load than they were being used on. I feel that the draft had very little to do with our particular trouble.

If there is anything here to help C.C.S. he's welcome to it. Since his trouble seems to be too much draft, it appears that the amount of draft in the fire box could be controlled by dampers on No. 9 and No. 10 boilers.

Chilocco, Okla. EDGAR SCROGGINS

Editor's Note:—He may be a small-time engineer, as he says, but he cured the trouble, didn't he?

Answer No. 453

CAN HE USE MOLASSES AS FUEL?

FOLLOWING the discussion of pumping molasses, Question No. 441, Reader P.F.S., in the December, 1949 issue, asked if there is any technical information on using molasses as a fuel. For those interested in pursuing the subject, Reader Toomy gives some clues.

Some Use of Molasses Fuel in Far East

There has been some use of molasses as a fuel at sugar mills in Australia and Java. You will find reference to it in Cane Sugar Handbook by Spencer-Meade, 8th Edition, Page 68, also in the International Sugar Journal, February 1932, Page 62.

New York J. F. TOOMY

Plant Electrics

A breezy but pointed dissertation on the importance of electric juice together with some slick suggestions about keeping it where it belongs

By A. E. RICHARDS

NOT LONG AGO, a century maybe, one guy started in to do something about a force being generated throughout our universe wherever motion exists. Rolling clouds, air movement, atmospheric differential produce great potential electric pressure, as shown in multi-million-volt lightning flashes, right down to dissimilar metals near or in contact with each other. For a long time little was done about it until industrial demand for new sources of energy made itself felt. Man burned fuel for centuries to warm himself but couldn't produce light except by torches and oil lamps or a wood fire to keep dinosaurs away.

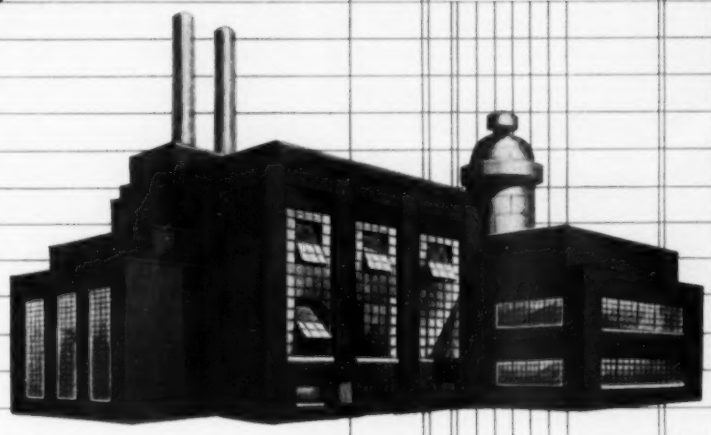
Now, however, by simply revolving metal loops between horseshoe magnets this bird produced heat and light and power which could be carried through a wire! Electricity stepped in KER-WHAM and without letup is stepping with greater impetus ever since. This medium has the advantage over steam power in being transmissable a couple of hundred miles and in furnishing light which no other process can do.

Our Resources

We never thought to arrange our population in correct relation to natural resources needed by that population. Great water powers running to Hudson Bay and the Arctic Ocean are too far from folks who need it. Oil and coal are pooled or piled on the Eastern Rocky slopes or way out under the Atlantic a long long way from satisfied customers. Natural gas is blowing away in millions of cubic feet where oil men have found it during their hectic quest. They don't seem much interested in gas except the verbal variety, and that used for motor cars. Oil men are single-track minded but when it comes to marketing their slippery juice they don't slouch any! Big and Little Inch pipelines stretch from Texas to Chicago. Bet a nickel Imperial or Standard or some of the big boys are drawing plans today for piping Leduc to Vancouver or Sault Ste. Marie. And you can be sure a lot of experiment and research is going on, on piping electric current from hydro sites to industries as they now are situated in a much more economical way than we have done it to date. A power line in the ground or overhead is greatly preferable to pipe lines or tank cars any old day, both in efficiency, upkeep and first cost.

We plebeians rate right up with the science boys as to what electricity really is, they say it is due to movement of electrons and can't explain what is an electron! We believe it

HOW TO PROTECT AN INVESTMENT



A boiler plant represents a sizeable investment . . . an investment requiring the best of protection. Progressive management recognizes that one of the most important phases of such protection is the use of an adequate and well-balanced program of water conditioning. This is the positive way of providing protection . . . to assure economical and efficient plant operation.

W. H. & L. D. BETZ is an organization of engineers and chemists specializing in the solution of all industrial water conditioning problems including boiler feedwater . . . cooling water . . . air conditioning and industrial waste treatment. Years of experience have made Betz water conditioning service scientifically correct . . . complete . . . economical. Whatever your particular water conditioning requirements, our staff of engineers is ready to serve you. W. H. & L. D. BETZ, Gillingham and Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories, Limited, Montreal 1.

BETZ

BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT

MOTOR SERVICE RECORD (FRONT)

DATE INSTALLED:

LOCATION	DRIVING	TYPE DRIVE	TESTS

REPAIRS DATE	CONDITION	CAUSE	REPAIRS	COST

REMARKS:

MOTOR (BACK)

DATE INSTALLED:

H.P.	SERIAL	MAKE	CONN DIAGRAM	DUTY

TYPE	FRAME	SPEED	VOLTS	TEMP	PHASE	CYCLES

PULLEY: DIA
FACE
BORE
KEYWAY
BELT

CONTROLS
TYPE MAKE NO.

REMARKS:

Record card for motor service (Front and back)

permeates all matter and produces energy when separated into positive and negative components. Undoubtedly it is convertible into heat and light both of which waves are closely related. By expenditure of energy it can be pumped through a conductor much as can water be pumped, flowing from atom to atom by atomic movement. Our insulating substances prevent this movement to some extent by the nature of their closebound atomic structure. By forcing it to move we produce power which travels instantly along or through conductors a couple of hundred miles long and pushes or pulls at end of journey according to positive or negative flow. Heat is developed by ampere passage through any conductor, usually lost to atmosphere and charged as "Line Losses." If not dissipated it would heat conductors to melting point.

Where Is The Elec?

Pressure times speed equals watts, 746 of which equal one horsepower. A horsepower applied to a good generator should produce 0.9 hp on the outgoing line. So we engineer Johnnies must needs have know-how in handling such equipment, what happens and why. Electricians are available for complicated detail of switchboards, transformers, windings, controls—sometimes. Did you ever find Elec quickly when you had a breakdown or stoppage? If so you're a better man than Ghunga Din. These elevators, refrigerators, motors great and small, won't wait many minutes before a big squawk straight to the power plant and you, dear.

Here's How

The following applies generally to care and operation of practically all types of motors and generators:

1. Keep records of troubles and cures. These will be a big help on future occasions. See sketch for sample record card for file, and trouble card kept on location preferably.

2. Build up a reserve of parts and sub-assemblies carded and ticketed for prospective use. Keep these parts clean, dry, in shape for immediate placement.

3. Keep your machine clean. First make sure it is dead mechanically and electrically. Remove dust by suction or gentle blow using non-conductor tips. Never blow directly into a machine. Use carbon tetrachloride on a soft hair brush for removing dirt, sparingly. Too much or too strong solutions will soften insulation.

4. A growling start or unusual noise strongly indicates worn or loose bearings. If bearings are worn your rotor will not be properly centered nor gapped and is badly handicapped. Check carefully by feeler gage top, bottom and side distances between stator and rotor.

5. Use best oil of correct grade, No. 20 for room temperature down to freezing, No. 30 for 50 deg to 100 deg and No. 40 for near or over 100 F.

Large motors are in general ring-oiled with which most engineers are quite familiar. Small units have a well at each bearing, packed with wicking held against revolving shaft by a spring. Overheat, of course, carbonizes oil and greatly lessens capillary action of wick oiling. Remove wick periodically, wash with soap and water or replace anew. Allow no surplus oil in or round bearings. If doubtful about any bearing have some qualified person in possession of pullers, reamers, pressers and other gadgets look after it.

Clean only with CTC. Other solutions may soften paint and allow oil creep along metal surfaces.

6. Do not use thick paint. Collective heat must be dissipated to atmosphere or will cause trouble.

7. Check drives and belts at least monthly for slackness, worn or loose gears, chains, or pulleys. V-belt wear is easier and cheaper to correct by replacing pulleys than belts.

8. See that there is continuous contact between commutator and brushes, that brushes move freely in holders, pigtails not touching any parts. Commutator should show smooth copper-oxide gloss varying from straw to chocolate, not black. Clean with a non-lint canvas fastened securely to a flat stick and no lubricant.

9. Overheat may indicate bearing trouble, overload, lack of lubrication or ventilation, dirty innards, internal shorting, wrong voltage, over or under excitation and a few other little faults.

One should carry a handy little two-legged test lamp available in a convenient case, like a medico carries his stethoscope and for the same purpose. A growler can be made or purchased as an aid in locating winding shorts etc., though this is probably outside the power engineer's field.

I can find very little *practical* literature extant to guide in every day handling, especially by men who are not electricians, except that they must operate the units satisfactorily. Ninety per cent of the textbooks and handbooks available go into tremendous uniform detail on theory, anodes to Wheatstone Bridge, molecules and magnetism, right and left hand rules, eddies and emfs which would surely bewilder anyone but an electrical engineer with years of study under his hatband. A good handbook on operation, trouble shooting, what to do and why, what not to do and why, would fill a big vacuum in the engineer's day. Show me such and I won't enquire the price! Many thousands of us boys are just itching to get our claws on one. Publishing houses may be missing something here. These remarks are pertinent to switchboards and controls especially. Unless the operator can intelligently read and understand complicated wiring diagrams and blue prints he must needs be very circumspect in laying on of hands.

Some things he can do with circumspection:

1. Switchboards, controls can be kept clean with an insulated nozzle vacuum cleaner, even while alive.

2. Broken or cracked glass or metal casings should be replaced at once particularly in dusty locations.

3. Bus bars and knife switches may show heating or even fusing. Contacts should be clean, smooth and adjusted for obvious reasons. They are silver to silver and tarnish

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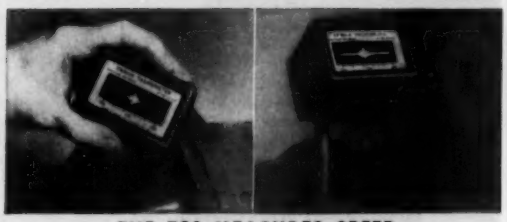

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easily. Clean with a knife. Never with emory or abrasive.

4. When a fuse burns out good practice replaces all those in that panel unit, follow through and find why. It is trying to tell you something important.

5. Keep dust from collecting on light bulbs. They will be brighter and last a lot longer.

6. Don't allow insulated wiring anywhere where it can be rubbed or scuffed. Place in conduit.

Finally use good housekeeping common sense with a lusty dash of A B C (always be careful).

Two Case Histories of Preventable Waste

These two case histories should be of interest and value to all operators responsible for the efficient operation of power equipment. Small in themselves, cumulatively they determine whether a plant operates at a profit or loss

By C. T. BAKER,

Consulting Engineer, Atlanta, Ga.

IT MATTERS NOT whether power is purchased or whether it is generated on the premises, uncalled for losses can occur in the use of power unless the engineer and the manager are awake to the many sources of losses and are governed accordingly.

The following case histories will serve to illustrate this point. In the first instance cited, power was generated on the premises; however, the situation as regards preventable waste would have been the same or perhaps worse had the plant been purchasing power from a power company.

The High Cost of Friction

The machinery in the plant was operated by a simple Corliss engine rated at 225 hp which was supplied with steam at a pressure at 135 psig. Indicator cards taken from this engine showed that with all machines running 220 indicated hp was being developed. Indicator cards taken for the purpose of determining the friction load with all machines out of service, disclosed that 35 per cent of the total engine horsepower developed at full load was consumed in friction by the various line shafts, counter shafts, etc. An examination of the transmission equipment showed one of the worst conditions that the writer has found in many years of experience.

The shafting throughout was, for the most part, out of level and alignment, due in part to improper erection and in part to the settling of the beams which supported the bearings and also in some instances, to the maladjustment of the flanged couplings where various sections of shafting were joined. This condition was reflected by a pronounced wabble in the shafting at these locations. Wherever the face of the coupling does not lie in a plane at right angles to the length of the section of shaft, trouble is inevitable.

What was needed in this particular instance was a complete overhauling of the shafting which would call for a relining and leveling of practically all of the transmission equipment in the mill. In addition to this, a great many of the journal bearings were not provided with proper means of lubrication with the result that considerable power was consumed by friction due to lack of oil. In some instances it was found that the belts were too light for the work required and in order to meet the load conditions, they had been tightened to such an extent that the friction imposed on the bearings was out of all proportion to that which would have been the case had the belts been selected in keeping with the requirements of the drive.

Waste of Heat

Usually, two dry kilns were kept in service for kiln drying lumber. These kilns were heated with steam supplied direct from the main boiler plant at 135 psi. Each kiln was fitted with one-inch heating coils containing several thousand square feet of heating surface. When steam was turned into these coils with a fresh loading of lumber and with the kiln cooled down, a great deal of steam was required for the first several hours of operation. The hot condensate was drained from these coils by steam traps, with the trap discharge turned into the sewer.

Since city water had to be purchased for boiler feed, it is evident that for each cubic foot of water wasted to the sewer, an equal amount of city water had to be purchased. In addition to the waste of water in this manner, a great amount of valuable heat was also thrown in the condensate which should have been returned to the boilers. In winter, considerable of both live and exhaust steam was required for heating. The resulting condensate from the heating system was likewise dumped into the sewer. Since there was not sufficient refuse to supply the fuel requirements, several tons of coal were required each day. This cost $4.50 per ton delivered.

The Boiler Plant

The boiler plant had been badly neglected and fuel was being wasted, actually thrown away because of this neglect. Stack dampers were not used as they had been removed and the condition of the boiler settings was deplorable. Great quantities of excess air entered the furnaces and combustion chamber due to openings and cracks in the brick work and since cold air thus admitted was heated by passing through the furnace and combustion chamber, it is evident that large quantities of heat were wasted to the stack, heat that otherwise would have been absorbed by the water in the boilers and converted into steam. It is sometimes argued that the power and heating cost in manufacturing is only a small percent of the total cost of production. This may be true, yet how can modern management tolerate waste on the scale as found to exist in the case under discussion.

Another Case History

The owner of a small mill who had long been troubled with excessive power costs, decided to have an investigation made to determine, if possible, the reason for such high power bills. The owner had, on many occasions, given it as his opinion that the trouble was due entirely to the Power Company's meter, claiming that it was fast and that even though he had made complaints to the Power Company, and they had checked this meter and reported it to be accurate, he still felt that they had either misrepresented the facts or had not made the proper check. In order to settle this question, the Power Company's meter was tested with a rotating standard which had only recently been carefully calibrated and was known to be accurate.

In checking the Power Company's meter by this standard it was found to be accurate within one half of one per cent which of course represents good commercial practice. In order to be absolutely certain as to this, several checks were made when the motors were operating at various loads, but in each case the results were the same.

Motor Tests

There was installed in this mill two motors, one a 75 hp and the

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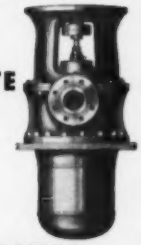

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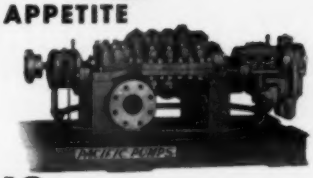

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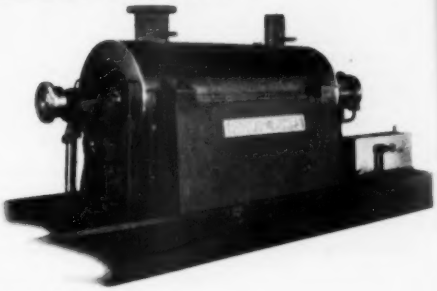

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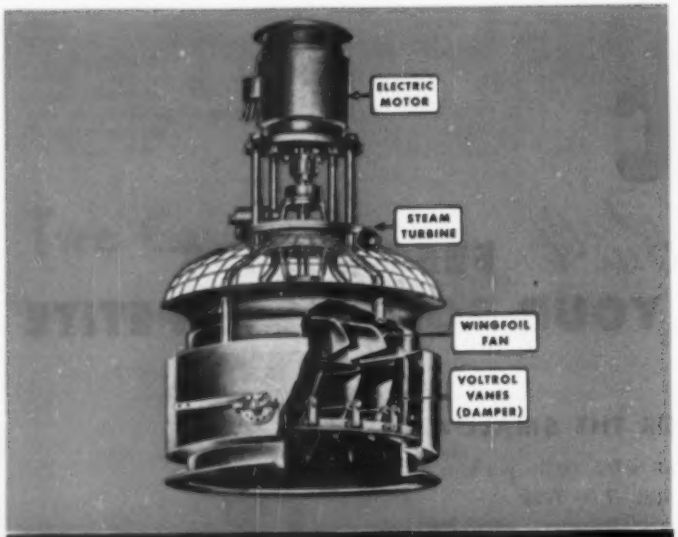

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other a 20 hp. Each of these motors were tested for input, the test being made with each carrying its normal load and a second test with the motors operating under friction load only. This developed some rather startling data, in fact the results were so unusual that a second test was made which included a combined test of both motors running at the same time.

This second test substantiated the first and showed that in the case of the combined operation the friction load amounted to 65 per cent of the total and that with the 75 hp running alone the friction load was 60 per cent of the total load on this motor while the 20 hp motor showed a friction load of 30 per cent of its total load. It is evident that here was a condition that was taking a heavy toll in the way of lost energy for which the management was compelled to pay in the form of power bills.

Condition of Transmission Equipment

An examination of the shafting, belt bearings, pulleys, etc., composing the power transmission equipment in the mill, disclosed one of the worst conditions that could be imagined. It developed that even though this mill had been in operation for many years, practically nothing had been done in the way of maintenance.

It was found that many of the sections of line shafting were out of alignment and that for most part the bearings were not being properly lubricated, and that the belts as a whole were not being properly cared for. Likewise, many of the belts were operated on close pulley centers where the ratio of pulley diameters were extremely bad and which called for many of the belts to be operated so tight as to cause excessive friction losses. In some places, settlement of the bearing supports was so pronounced as to throw long sections of the shafting out of alignment. The coupling on the main line shaft on the second floor of the building was in such condition as to cause a severe wobbling of the shaft which was clearly evidenced by the shaking and vibrating of the hanger bearings.

Only a few of the bearings were protected against the entrance of grit and dirt and the oil had not been changed in the oil wells since the mill had been in service. In some cases, belts were used that were too small to transmit the required power without their being operated as tight as fiddle-strings. To overcome troubles due to belt slippage a sticky belt dressing of questionable quality and utility was being used. This only made an already bad condition worse.

Belts were observed running off to one side of many of the pulleys indicating that in many cases the driving and driven pulleys were not in alignment. In some cases wood

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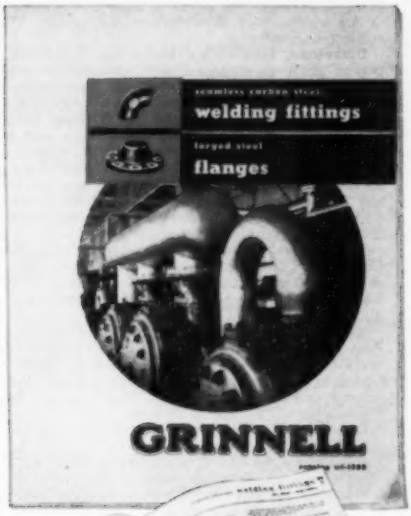

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SEAMLESS CARBON STEEL BUTT WELDING FITTINGS

90° elbows . . . long radius, short radius, light gauge, special wall thicknesses
45° elbows . . . long radius, light gauge, special wall thicknesses
180° returns . . . long radius, extra long radius, short radius, light gauge, special wall thicknesses
tees . . . straight, reducing
crosses
reducers
laterals
lap joint stub ends
caps
saddles
backing rings
dimensional tolerances

FORGED STEEL FLANGES

welding neck . . . 150 to 2500 lbs.
slip-on . . . 150 to 2500 lbs.
lap-joint . . . 150 to 2500 lbs.
threaded . . . 150 to 2500 lbs.
blind . . . 150 to 2500 lbs.
socket type . . . 150, 300, 600 lbs.
reducing . . . threaded and slip-on: 150 to 2500 lbs.
orifice . . . slip-on; welding neck; welding neck, ring joint; threaded: 300 to 1500 lbs.
flange extras
dimensional tolerances
minimum finished bores
flange facings
facing dimensions of ring joint flanges
thread standards and threading practice
service pressure ratings
physical and chemical requirements

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guards had been erected to prevent the belts from running entirely off the pulleys.

After these matters were brought to the attention of the management it was agreed that a competent millwright would be immediately employed to completely overhaul and rearrange the transmission equipment in order that the excessive power cost might be eliminated.

This case serves to illustrate the tendency on the part of some managers and engineers to place the blame for unfavorable results where it should not be placed, rather than to insist on first getting the facts and then putting their own house in order.

POWER PLANT CONSTRUCTION NEWS

(Continued from page 50)

steam-electric generating station, with initial capacity of 45,000-kw. Project reported to cost over $2,500,000, with power substation, transmission lines and other operating facilities. Financing will be arranged through Federal aid.

Athens, Ohio—State Department of Public Welfare, State Office Bldg., Columbus, Ohio, plans new boiler house at Athens State Hospital for central-heating service at institution. Cost reported about $225,000. William C. Kemmerer & Associates, 1900 Euclid Ave., Cleveland, Ohio, are consulting engineers.

Cleveland, Ohio—Ford Motor Co., Dearborn, Mich., plans power plant at proposed new automobile engine manufacturing works on 200-acre tract of land between Brookpark and Hummel Rds., Cleveland. It will comprise several buildings, totaling about 1,700,000 sq. ft. floor space. Plant will require close to 18 mos. for completion and is reported to cost close to $80,000,000. Plans will be prepared at once.

Reading, Ohio—City Council plans extensions and improvements in municipal steam-electric generating station, including installation of new 4000-kva. turbine-generating unit, boiler and auxiliary equipment. Plans will be prepared soon. Estimates of cost being made.

Youngstown, Ohio—Republic Steel Corp., Republic Bldg., Cleveland, Ohio, plans new steam-electric generating station at mill at Youngstown, reported to cost in excess of $5,000,000, with turbine-generators, high-pressure boilers and auxiliary equipment.

Downington, Pa.—Downington Joint High School Board, 322 East Washington St., plans central-heating plant in new multi-story junior-senior high school. Entire project estimated to cost about $500,000. Work is scheduled to be carried out in spring. MacKenzie & Wigmore, 117 South 17th St., Philadelphia, Pa., are architects.

Lancaster, Pa.—Armstrong Cork Co., cork insulation products, composition flooring, etc., has plans for new boiler house at local factory. Cost reported over $85,000, with equipment. Proposed to begin work soon.

Kingsport, Tenn.—Tennessee Valley Authority, 717 Church St., Nashville, Tenn., plans two new hydroelectric power projects on South Fork of Holston River, near Kingsport, to be known as Boone dam and Fort Henry dam, respectively, estimated to cost about $27,000,000 and $13,000,000, respectively, including power dams, generating stations, power substations, transmission lines and other operating facilities.

Beaumont, Tex.—Gulf States Utilities Co., Beaumont, is arranging for sale of 350,000 shares of stock, proceeds to be used as part of fund required for extensions and improvements in plants and system during 1950, including increase in generating capacity.

St. Albans, Vt.—Corps of U. S. Engineers, Office of District Engineer, Army Base, Boston, Mass., plans call for bids soon for new boiler plant at Bellevue Hill State Park, St. Albans, for central-heating service, with installation of three coal-fired watertube boilers and auxiliary equipment. Also for booster pumping station at same place.

Beloit, Wis.—Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago, Il., machinery for various service, locomotives, motors, etc., has authorized plans for new power plant at branch works at Beloit, reported to cost over $2,000,000, with generators, boilers and accessory equipment. Stone & Webster Engineering Corp., 33 South Clark St., Chicago, and 49 Federal St., Boston, Mass., is engineer.

Rhinelander, Wis.—Wisconsin Public Service Corp., Bellin Bldg., Green Bay, Wis., has begun surveys and plans for new hydroelectric generating station on Menard Isle in Wisconsin River, vicinity of Rhinelander. No estimate of cost announced.

South Milwaukee, Wis.—Bucyrus-Erie Co., 1100 Milwaukee Ave., machinery, has authorized plans for new power plant at factory, to provide increased generating facilities for production service. Details and estimates of cost will be determined soon. Gates, Moe, Weiss & Papenthien, 611 North Broadway, Milwaukee, Wis., are consulting engineers.

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How to Replace Standby Storage Batteries Without Service Interruption

FROM TIME TO TIME it becomes necessary to install new standby storage batteries, and at these times it is often highly desirable to make the changeover without interruption of service. One method of achieving this end is shown in the diagram.

Step 1 shows two sets of 12 cells, the shaded cells representing the new battery to be installed. In the top row, the old battery is completely connected to the circuit and the new battery is connected in groups of six cells each. This gives an opportunity to inspect the new cells thoroughly before disturbing the old circuit. By tying the new cells together, it can be determined whether the cells are in good order ready for installation. In addition, any shortage of connectors or other parts will be immediately apparent.

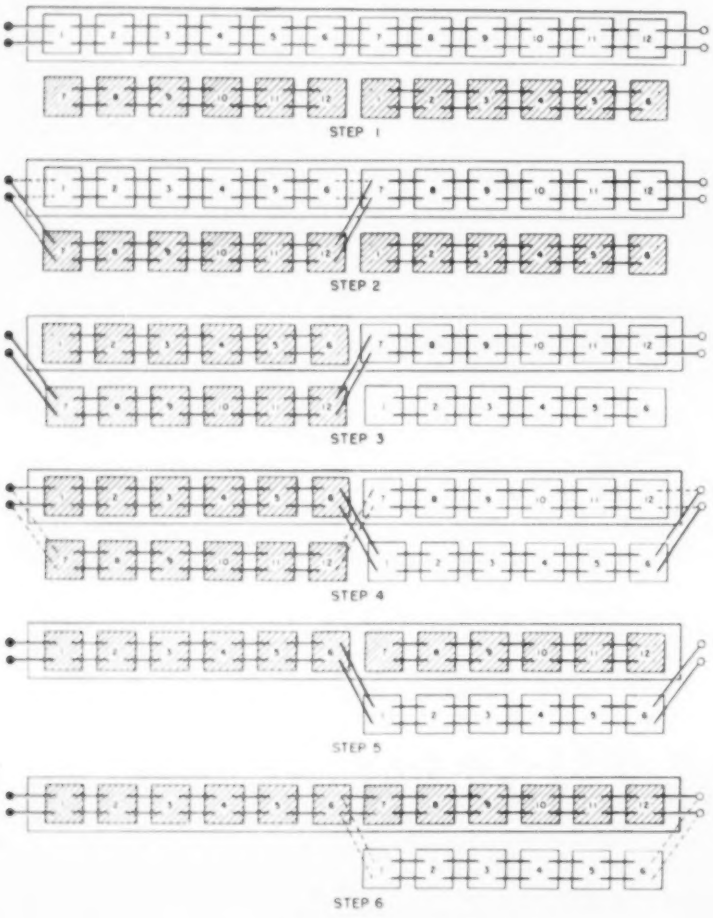
In Step 2, flexible leads have been connected to cell 7 of the new battery from the same terminal as those connected to cell 1 of the old battery. Connectors to be removed are indicated by dotted lines. Flexible connectors have also been installed between cell 12 of the new battery and cell 7 of the old battery. This allows removal of connectors between terminal and cell 1 and also the connectors between cells 6 and 7 of the old battery without breaking the circuit. The circuit now becomes cells 7, 8, 9, 10, 11 and 12 in the new battery, and cells 7, 8, 9, 10, 11 and 12 in the old battery. Cells 1 to 6 in the old battery can be removed and replaced with cells 1 to 6 of the new battery.

Cells 1 to 6 of the old battery are placed on the floor and connected in series so that they can be used to maintain a full circuit in Step 4.

Step 4 is similar to Step 2. However, in this case, when cells 7 to 12 in the old battery are removed from the circuit, they are placed in the packing case in which the new battery arrived and removed from the battery room. This is indicated in Step 5.

In Step 6 the final connections are made and the old batteries completely removed from the circuit.

The illustration with full instructions is available on an 8½x11 in. sheet suitable for insertion in reference notebooks. Copies may be had by writing the Gould Storage Battery Corp., Trenton 7, N. J. Refer to "Gould Technical Bulletin, GB-1084."



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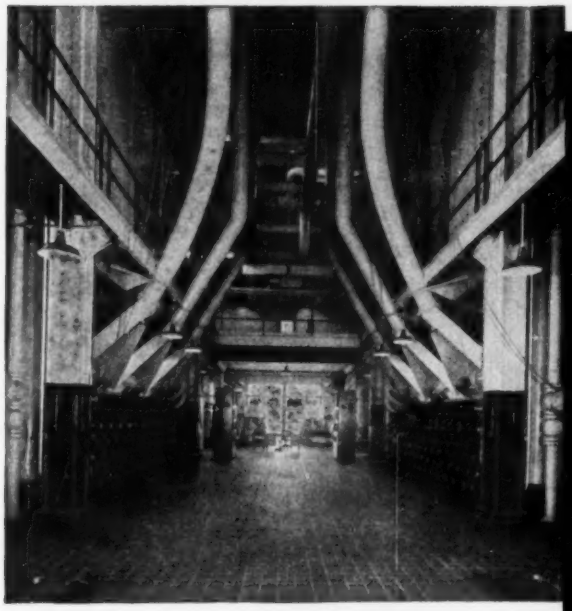

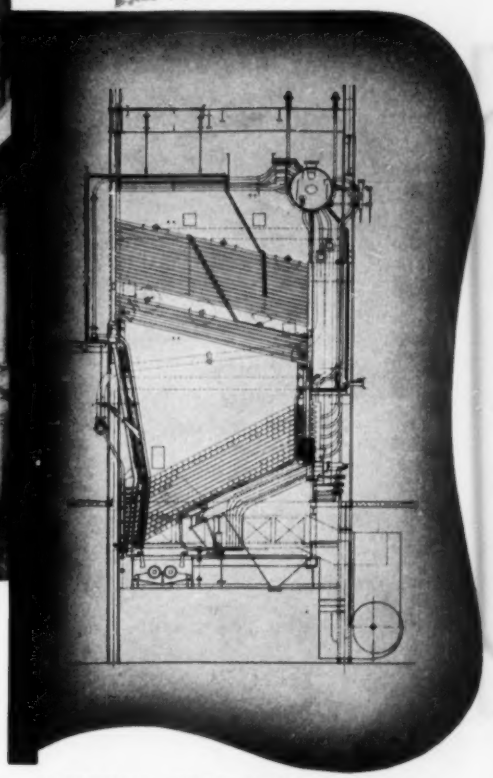

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G. E. to Launch Train of Apparatus Exhibits

THE "MORE POWER TO AMERICA SPECIAL," first train of its kind in industrial history, will be launched on a nationwide tour this spring by General Electric's Apparatus Department.

Exhibits of more than 2000 electrical products, processes and techniques ranging from precise aircraft instruments to complex working models of steel mill, textile and other industry equipment, will be displayed throughout nine cars of the train.

C. H. Lang, vice president in charge of sales for the company's Apparatus Department, said the train will visit the country's key industrial centers for inspection by utility and industrial executives and municipal leaders.

Since it is an industrial development enterprise, it will not be open to the general public.

Pointing out that the exhibits will dramatize the latest apparatus and ideas for producing and using electric power most efficiently, Mr. Lang hailed the mammoth "showcase on wheels" as a symbol of the contributions the entire electrical industry is making to the progress of industrial America.

J. S. Smith, divisions manager, said the extensive series of related exhibits, filling nine cars of the train, will represent the best combined thinking of the Apparatus Department's research, engineering, manufacturing and sales personnel.

At the same time, he disclosed that a special group—the Apparatus Exhibit Train Division—was set up early last year as part of his organization with responsibility for preparation and operation of the train. This division is managed by C. P. Fisher, Jr.

The displays will portray the latest advances in power generation and methods and equipment for the profitable use of electricity throughout all industry. They have been designed especially for those who produce electric power and those who put it to work in industry and the community.

Included in the exhibits will be turbines of all types—steam, gas and mercury; equipment for transmitting and distributing electric power, and motors and controls engineered into combinations that can perform a wide variety of industrial operations.

Other displays will include precise measuring and recording instruments; new developments for community improvement, such as street lighting and sewage treatment equipment, and products which contribute to national security.

The train will be hauled by an Alco-G-E two unit, 4000-hp, diesel-electric locomotive which itself will be part of the unusual series of displays. The cars are being built by the Pullman Standard Car Manufacturing Company.

Inspecting a scale model of one of the exhibit cars of General Electric's "More Power to America Special" are, left to right: C. H. Lang, Vice President in Charge of Sales, Apparatus Department; C. P. Fisher, Jr., Manager of the Apparatus Exhibit Train Division; and J. S. Smith, Manager of the Apparatus Department's Advertising and Sales Promotion Divisions

WIDOW'S CREEK 250-MW STEAM PLANT FOR TVA

PLANS FOR a 250,000 kw steam-electric generating plant, to be built near Bridgeport, Alabama, where Widow's Creek enters the Tennessee River, are being made by TVA. This is regarded as a key development in two major national defense projects—the atomic energy and air research programs.

The initial installation at Widow's Creek is planned to consist of two 125,000-kw turbine generators. It will supply energy to replace that now flowing into the area from the northern section of the TVA system, thus leaving more power in the Oak Ridge area for AEC requirements. Also, it will help to meet major new off-peak demands for TVA power for the Air Development Center near Tullahoma, Tennessee.

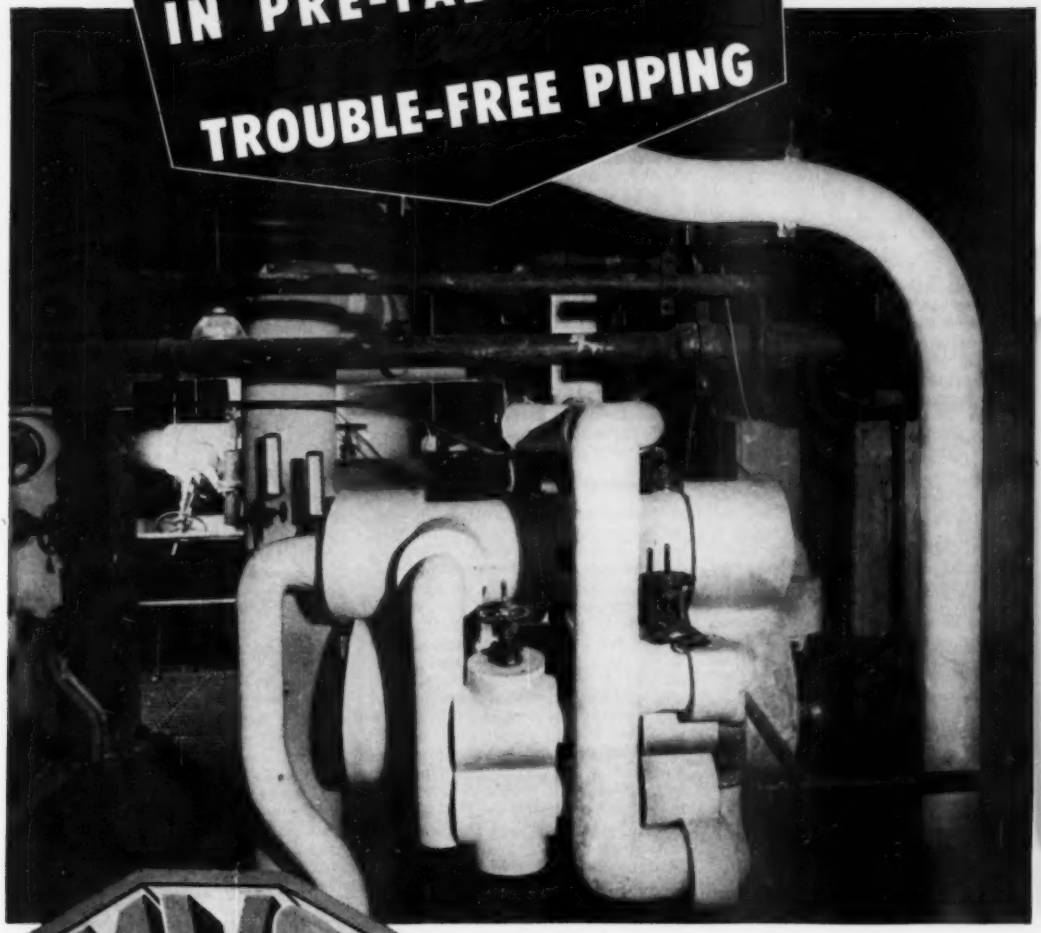
COMMONWEALTH SERVICES, INC. FORMED

NEW ORGANIZATION, Commonwealth Services, Inc., has been formed upon the dissolution of The Commonwealth & Southern Corp. This organization is composed of the engineering and technical staffs that have for many years provided a variety of services to affiliated companies of the former Commonwealth & Southern Corp. The new company is wholly owned by its employees and is now prepared to engage in general practice. Engineering work will be handled through its subsidiary company, Commonwealth Associates, Inc., all of whose officers and directors are registered professional engineers.

Commonwealth engineering services are available for public utilities, industries and other organizations and full information about them may be obtained from George C. Daniels, Chief Mechanical Engineer, Commonwealth Associates, Inc., 212 W. Michigan Avenue, Jackson, Michigan. J. H. Foote is in charge of engineering with Ed. F. Dissmeyer, as general staff engineer; George C. Daniels, chief mechanical engineer; Russell W. Parkinson, assistant chief mechanical engineer; Henry F. Behrens, mechanical design; R. I. Olson, architect; Howard W. Slack, plant layout; M. L. Whiting, structural design; J. R. North, chief electrical engineer; Frank E. Sanford, assistant chief electrical engineer; Wm. R. Brownlee, power systems; J. A. Elzi, electrical equipment; John N. Gosinski, economic analyses; Cy J. Hartman, station layout; Charles E. Waits, transmission lines and Harry R. Wall, distribution systems.

In addition to the engineering services, Commonwealth Services, Inc., offers general consulting, reports, investigations, rate research, purchasing, merchandising and a variety of other services to industry.

NAVCO ACCURACY IN PRE-FABRICATION TROUBLE-FREE PIPING



Prefabrication accuracy is an essential "MUST" to assure a proper fit and economical operation. Navco's 40 years' experience in fabricating assemblies in all sizes and for all operating conditions is your assurance of such accuracy.
Consult Navco for your next piping job.

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Better Engineering Can Reduce Small Industrial Steam Plant Costs

STEAM PRODUCING COSTS in the small industrial steam plant, ranging from 150 to 1,500 rated horsepower, are, with few exceptions, excessive, according to Solon E. Friedeberg, vice president of the Franklin Engineering Corp., consulting engineers. Mr. Friedeberg told the Metropolitan Section of the ASME recently that these plants lack engineering talent and have done little in reducing the amount of labor necessary for operation and maintenance.

Generally speaking, said Mr. Friedeberg, the small industrial steam plant is operated by personnel who have had at best, little technical training. He advised young engineers that they would find increasing opportunities in smaller industries which might not contain an engineering department but would offer increasing technical employment.

"Expansion of an industrial plant almost always requires increased service facilities, of which steam for processing, heating, power or refrigeration is an important factor," he declared. "When such expansion is contemplated, the time is opportune to conduct a complete survey of steam generating capacities and the physical condition of such equipment. The survey must also cover existing steam requirements and the increase of steam load that will be imposed on the steam plant must be determined fairly accurately."

Unsound Methods

Too often when the need for economy or a larger steam supply becomes evident, the improvement, expansion or building of new steam generating facilities is undertaken without necessary engineering information and data, said Mr. Friedeberg.

"These are unsound methods and usually result in a plant unable to produce the results anticipated, or one in which the investment is such that fixed charges are out of line with operating costs," he declared.

"Proposals for steam plant improvement must evidence good engineering and be economically sound to interest plant management," he said. "Many opportunities are existent for plant betterment and unless investment in boiler plant improvements can show equally favorable returns they are not likely to be considered.

"The development of any plan for boiler plant improvement will require information as to existing steam generation and the cost to produce same. The steam generated should be measured. The cost of such equipment is usually less than one per cent of an annual fuel bill. No valid reason exists for not installing equipment to measure the quantity of steam produced. A record of fuel used should also be kept. Fuel-oil and gas can be readily metered. With a little ingenuity the volume of coal consumed can be recorded, converted to pounds and checked periodically against invoices or bills of lading. Knowledge as to the quantity of steam generated per pound of fuel consumed, together with the calorific value of the fuel used, the steam pressure and temperature of the feed-water will be sufficient to approximate boiler plant efficiencies. The existing level of boiler plant efficiency will be a determining factor as to the extent of improvement. Many conditions cause poor boiler plant efficiency. Their cause should be determined by engineers who are qualified to conduct such investigations.

Combustion Controls A Help

"Instructing personnel in the proper methods of burning fuel will bring about economies. However, the installation of combustion controls is a definite aid in maintaining such economies, especially where fuel-oil or gas is used. Mechanical means are gradually replacing hand firing in small industrial steam plants. A good stoker installation will effect considerable economy and pay for itself in a reasonable length of time. Plants using coal should also consider coal handling equipment as a means of reducing the amount of labor required to operate the boiler plant."

Mr. Friedeberg said the mechanization of the plants and the consequent elimination of menial labor would attract higher types of personnel as attendants who would not only maintain the plant in better physical condition but would be capable of keeping records of value to management in determining the cost of steam production.

"Boiler plant auxiliaries as well as the boiler house structure should receive careful planning," he said. "The results produced by the expansion of an existing boiler plant or the building of a new boiler plant will be directly proportional to the kind of engineering that went into its conception."

Editor's Note:—For other discussion of small plant improvement, see Design of Small Power Plants, by H. C. Carroll, *Power Plant Engineering*, August, 1946; and How to Use Heat Balance in Improving Industrial Power Plants, by H. C. Carroll, Power Generation, March, 1947.

COLUMBIA UNIVERSITY has launched the first phase of a long-range campaign to build a new engineering center on New York's Riverside Drive, a short distance from the University's Campus. The project will aim at the purchase of a five-story building on West 125th Street, adjacent to Riverside Drive, from the Sheffield Farms Co., to be used for engineering operations requiring steam, refrigeration, large amounts of water and the like.

Meanwhile, building plans are now being drawn for the new Center, to be located on land adjoining the Sheffield Farms building. Structures will be distinctive, yet fully functional, designed to suit the engineering projects to be carried on in the Center. This Center is intended to provide not only a research laboratory but an excellent training facility for top-flight engineers, where engineering and other industrial and business firms will be able to find the various kinds of talent they require to carry on their expanding operations.

FRED L. DORNBROOK, general consultant, Power Plant Department, Wisconsin Electric Power Co., Milwaukee, Wisc., was awarded the ASME Medal, highest honor of the Society, for outstanding engineering in the research, design and operation of pulverized fuel combustion equipment. Mr. Dornbrook received the award at the Honors Night dinner of the Society's 70th annual meeting in New York in December 1949.

The award carried the following citation: "Starting his engineering career as a coal passer on a lake boat, he advanced rapidly to positions of increasing opportunity and responsibility in electricity generating stations. He early visualized the possibilities of burning pulverized coal for the generation of steam, and rendered outstanding service through untiring effort in the pioneer development, design, and operation of pulverized coal-fired power-generating plants."

COMING EVENTS

ASME—Oil & Gas Power Division conference, Lord Baltimore Hotel, Baltimore, Md., June 12 to 16.

MPC—The twelfth annual Midwest Power Conference will be held at the Hotel Sherman, Chicago, April 5-7.

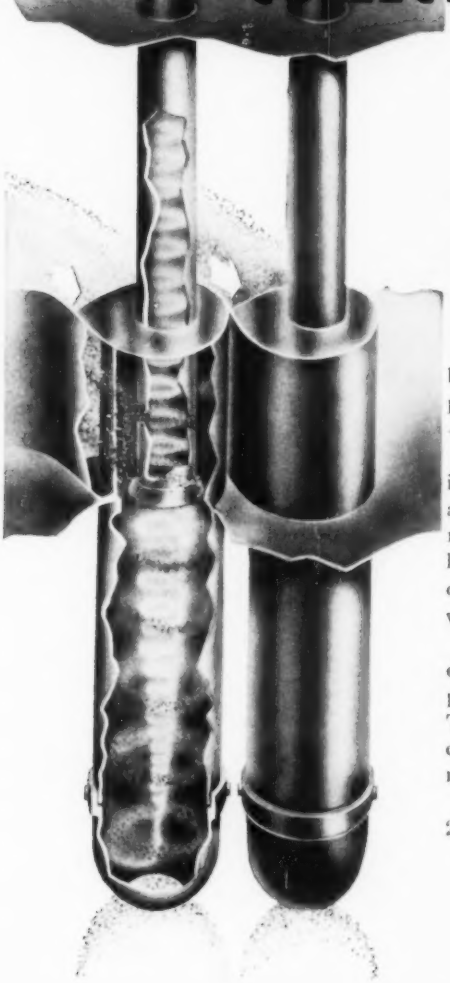
ASME—The Spring Meeting of The American Society of Mechanical Engineers will be held at the Hotel Statler, Washington, D. C., April 12-14.

AIEE—American Institute of Electrical Engineers to hold its Power Conference at the Wm. Penn Hotel, Pittsburgh, April 19. Power Generation; April 20, Industrial Power Systems.

ASME—The Semi Annual Meeting of The American Society of Mechanical Engineers will be held at the Hotel Statler, St. Louis, Mo., June 19-23.

ISA—The 1950 Instrument Conference and Exhibit of the Instrument Society of America, will be held in the Memorial Auditorium, Buffalo, New York from September 18-22.

THE INLET THAT *Boosted* COLLECTION *Efficiency*



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VALMONT TYPE S DUST COLLECTOR

High collection efficiency in the ultra-fine dust range below 20 microns was the goal attained by Prat-Daniel Corporation with the introduction of the Valmont Cyclonic Tube—the tube with a high, narrow inlet.

The advantage of this patented inlet proportion design is that it reduces the radial distance of travel of dust particles as they spiral downward. Ultra-fine particles, entering the high, narrow inlet of the Valmont Type S Tube near the center, have less distance to travel to the tube wall and a greater percentage of them will reach that wall before the downward spiral is ended, without excessive tangential velocities normally required.

As dust codes become more stringent, the high mechanical collection efficiency of the Valmont Type S becomes more important. Due to a series of design improvements, the Valmont Type S Tube offers improved aerodynamic flow, increased capacity per tube with resulting decrease in space requirements, weight and price.

Valmont Type S Tubes are shipped in "uniblocs" of 15, 20 or 25 tubes each, materially reducing erection costs.

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New ENGINEERING BOOKS

Electric Motor Repair, by Robert Rosenberg. First Edition; 551 pages; size 6¾ by 9 in.; spiral binding with a paper cover. Published by Murray Hill Books, Inc., 232 Madison Avenue, New York, N. Y.; 1949.

This is an extremely practical book that actually shows the man with little electrical knowledge how to repair all kinds of electric motors. It is easy to read and easy to understand. Stripped of all theory and nonessentials, it points out the best and quickest methods of testing, repairing and rewinding, and teaches troubleshooters and repairmen how to do satisfactory work in the shortest possible time. The book covers everything that is needed. Primary attention is sharply focused on troubleshooting and repair with complete instructions on rewinding. Included are individual chapters on each of the more common types of a-c and d-c motors, plus chapters on motor control systems, synchronous motors, generators, synchronous and electronic control of motors. Each subject discussion is followed by a quick-reference summary of troubleshooting and repair suggestions to serve as an actual working guide on specific jobs.

The book is built in two sections, which open opposite each other. Half of the book, one entire binding section, is made up of drawings intended to be used as a direct working guide for the repairman as well as to help the student gain a clearer understanding of the text.

This two-section arrangement permits the text and related illustrations to be exposed to view simultaneously, yet allows any desired illustration to be located instantly and permits the open book to lie flat on the workbench. The type is large enough to be easily readable from the bench. The cover is soil-and wear-resistant and the paper is strong and durable, selected to withstand hard wear under shop conditions. The book is designed to be used as you work. Every engineer or maintenance man or plant electrician who has electric motors under his charge will be very much interested in this unique volume.

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Basic Electronics, by Royce G. Kloeffler and Maurice W. Horrell. First Edition; 435 pages; illustrated; 6¼ by 9¼ in.; cloth. Published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York City; 1949. Price $5.00.

This book covers the fundamental theory of electronics in unusually condensed form. It was intended as a first course in electronics. The authors assume that the reader has a knowledge of elementary physics, but no previous training in electronics.

The authors' intent has been to fill a gap in available textbooks that seems to lie between books that are elementary and those that contain too much material to be included in a college recitation course of four to six semester hours. Many of the diagrams and equations are included to clarify the discussion in the text. Beginning with a general discussion of physical concepts, a rather comprehensive consideration of electron emission is given and then the book goes on with a more or less detailed discussion of various types of vacuum tubes and amplifiers. After this there is a chapter on electron tube oscillators and one on modulation and detection. The latter half of the book is devoted to the subject of electrical conduction in gases and the details of gaseous and vapor electron tubes, crystal and metallic rectifiers, photoelectricity and special applications.

About the authors: Royce G. Kloeffler has been teaching basic principles of electronics to college students since 1931; Maurice W. Horrell has had extensive experience in many parts of the electronics field, including manufacture, design and research. At the present time he is Supervisory Engineer in the Research Laboratories of the Bendix Aviation Corp. Mr. Kloeffler has been Professor and Head of the Department of Electrical Engineering at Kansas State College since 1927.

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Alternating Current Machinery, by I. V. Bewley. First Edition; 376 pages; size 6 by 9½ in.; cloth. Published by The Macmillan Co., 60 Fifth Avenue, New York, N. Y.; 1949. Price $5.25.

Justification for another book on alternating current machinery, according to the author of this book, lies in the real need for a modern text that will present the more recent advances in theory and methods of analysis, and that will break away from some of the false premises and artificial concepts that have plagued this subject for half a century. Mr. Bewley is Professor and Director of the Curriculum in Electrical Engineering at Lehigh University, and has had broad experience in both the practical and theoretical phases of electrical engineering. As he points out, the present text does not pretend to be a comprehensive treatment covering all types of electrical apparatus, but rather a good method of analysis applied to the more important kinds of alternating current machinery.

In certain respects the methods of this text differ radically from those found in standard treatises. Its key features are a general equation of voltage, which recognizes the simultaneous movement of the conductors, displacement of the flux and pulsation of the flux, and which includes as special cases all the processes of voltage induction to be found in any machine; and a general equation of armature reaction which applies to any machine, a-c or d-c. From the point of view of these general equations, one machine differs from another only in the presence or absence of specific terms, and thus great unification of concept ensues.

As the author points out, his original intention in writing this book has been to base the whole of the machine theory on these two general concepts, but as the work progressed it became apparent that many of the accepted methods of machine analysis would fall by the wayside if a completely unified method of attack were followed too strictly. It seemed better, therefore, while preserving the central theme of a general method of attack, to weave into the analysis the older and more widely known procedures.

Other features representing essential departures from traditional treatments may be mentioned. The concept of a fictitious winding in a transformer to account for the core loss permits the equivalent circuit to be derived from the differential equations as well as by the traditional Steinmetz method, and there is no need to apologize for the failure of the core loss term to materialize. The parallel piecemeal development of the equations, vector diagrams, and equivalent circuits employed in the treatment of the transformer, and of the polyphase induction motor, are believed to offer a clearer and cleaner approach to the study of these machines than is otherwise possible.

The text does not try to avoid long mathematical manipulations in cases where such are essential to a reasonably complete understanding of electrical machinery. However, it must be pointed out that most of them involve nothing more than simple trigonometric and algebraic transformations. They are time consuming, but not difficult.

On the whole, this is a very intriguing and stimulating book for the practicing electrical engineer as well as the student. The book was written with the dual intention of providing a text for the immediate needs of the students taking the course in alternating current machinery at Lehigh University and of supplying a reference source for further study.

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The Electric Power Industry—Past, Present and Future—by the Editorial Staff of the Electrical World. First Edition; 178 pages; illustrated; 9 by 11 in.; cloth. Published by McGraw-Hill Book Co., 330 West 42nd Street, New York 18, N. Y.; 1949. Price $3.50.

This book is the record of the evolution of energy generation, distribution and utilization—reporting the progress of the great American electric-power systems, both private and public, and covering the philosophy and social and economic forces underlying this growth.

It is a unique account of the development of hydro- and steam turbo-electric power plants; of techniques for the construction, operation and maintenance of the far-flung systems; of public regulations over companies, their rates and their profits; of the spasmodic movements for municipal and federal ownership of electric utilities; and of the rise of industry organizations.

Wherever pertinent, comparisons are made between the U. S. and foreign developments in the fields of power generation, transmission, and use. The part our industry has played in supplying the components for the systems of other countries becomes strikingly evident from these pages.

Outstanding authorities in all electrical fields have contributed to this permanent log of industrial achievement. This volume is a fitting tribute to the leaders who have built this industry.

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Electrical Engineers' Handbook, Volume I—Electric Power. Editor-in-Chief, Harold Pender, with William A. Del Mar as Co-editor. Fourth Edition; 1716 pages; 907 illustrations, size 5⅝ by 8⅜ in.; bound in Altholeather of dark maroon color. Published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y.; 1949. Price $8.50.

The Fourth Edition of the Pender Handbook retains all the features which highlighted earlier editions. This includes copious illustrations, thorough presentation, compact and durable format, and at the same time the work has been enlarged and completely rewritten for increased usefulness. The increased specialization in the field of electrical engineering is reflected in the handbook by the inclusion of more information and current data.

The Pender Electrical Engineers' Handbook is divided into two volumes. This Volume is No. I and is devoted to Electric Power. A second volume, Volume II, devoted to communication and electronics, is in preparation and will be published shortly. This volume is one of the Wiley Engineering Handbook Series.

Volume I on Electric Power is comprised of 19 sections, divided and sub-divided for easy reference and clarity. Increased attention has been given to subjects which have become more important in recent years. Notable among these on the theoretical side are circuit stability and symmetrical components; and, among items of equipment: electronic rectifiers, heat pumps, plastic insulating materials, induction and dielectric heating. The engineer can refer to this volume for dependable information on such things as lighting and heating, properties of materials, lamps and illumination, insulated wires and cables, air conditioning and much more.

It is impossible in a short review to give a comprehensive explanation of the tremendous amount of information that is contained between the covers of this book. The following list of subjects, however, will give some idea of what is covered. The subjects include: Mathematics, Units and Symbols; Properties of Materials; Electric Circuits and Electric Lines; Principles of Electrochemistry; Measurements and Measuring Apparatus; Resistors; Reactors; Rheostats; Capacitors; Electromagnets and Permanent Magnets; Batteries; Direct-Current Machines and Rotary Energy Converters; Alternating-Current Generators and Motors; Transformers; Power Rectifiers and Inverters; Switchgear and Control Equipment; Power Stations and Substations; Power Transmission Substations; Lighting and Heating; Industrial Applications of Motors and Servomechanisms; Transportation; Electrochemical and Electrothermal Processes; Rural Electrification Distribution Systems.

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Pump Questions and Answers, by Roy Carter, Igor J. Karassik and Elliott F. Wright; and various associates; first edition; 345 pages; illustrated; size 6 by 9 in.; cloth binding; published by the McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 18, N. Y. Price $5.00.

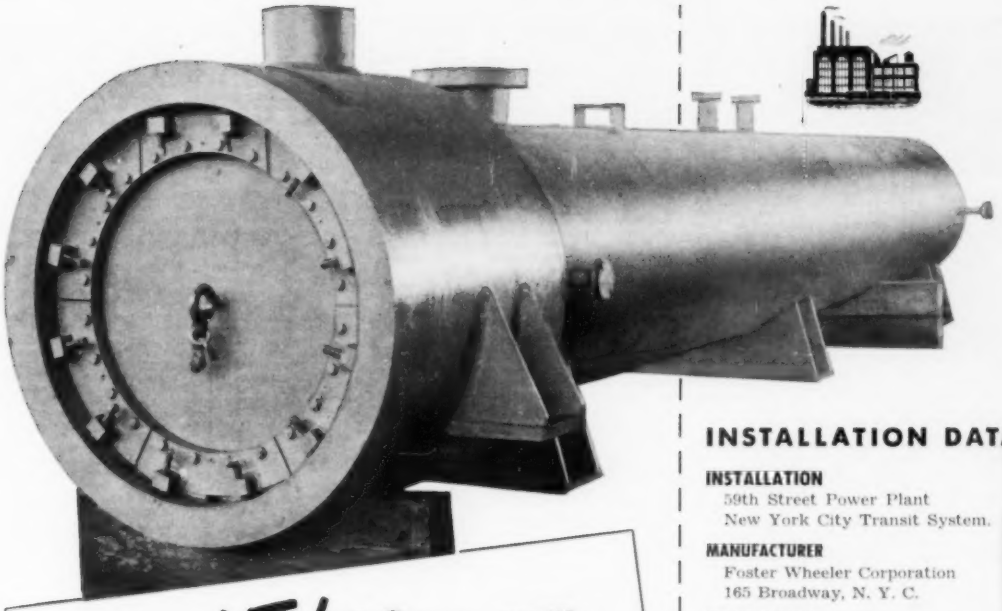
Two of the authors of this book, Messrs. Carter and Karassik, are well known to the readers of POWER GENERATION and other power engineering magazines for their very practical contributions to the data on modern pumps and modern methods of pumping. They are joined by a colleague, Elliott F. Wright and others in their company, Worthington Pump and Machinery Corp., in preparing this first edition of a very practical book.

It is made up of 5 major sections dealing, respectively, with centrifugal, vertical turbine, regenerative rotary and reciprocating pumps. Most of the material has been published in the form of magazine articles.

The discussion is in the form of questions and answers which leads to a direct form of presentation with few ifs, ands and buts, and seems to please many operating engineers.

The section on centrifugal pumps opens with a description of these pumps and their parts, shows their various classifications and treats the materials used in their construction. Discussion of centrifugal pump and system characteristics is followed by an analysis of the operating characteristics, and of the application of these pumps. Complete treatment is given to the installation, operation and maintenance of centrifugal pumps and of centrifugal pump troubles, their symptoms and their cure. A final chapter on centrifugal pumps treats the very important subject of priming.

The sections dealing with vertical tur-



Monel Tubes have many advantages in Boiler Feed-water Heaters

Foster Wheeler Corporation designed and built the above boiler feed-water heater (and a mate) for the 59th Street Power Plant of the New York City Transit System, to specifications set by Burns and Roe, Inc.

And into each heater went 550 Monel® U-tubes . . . *insurance for long, efficient service.*

Here are some of the reasons why Monel was specified in place of more commonly-used metals:

1. Higher mechanical properties . . . which means better heat transfer because lighter gauges can be used.
2. Better all-'round corrosion resistance . . . which means longer life, fewer failures, less "downtime."
3. Greater hardness . . . which means better resistance to erosion and cavitation. And when tubes stay smooth, you get faster flow, better heat transfer.
4. High ductility . . . which means tight rolled joints in tube sheets, and ease of forming bends in U-tube heaters.
5. Easy weldability . . . which means conventional welding techniques can be used to weld the Monel tubes into the steel tube sheet, if welding is specified.

Consider Monel the next time you design, install or re-tube a heater. No other metal offers so many advantages for this use. For more information on Monel heater tubes, write to P. F. Sheridan at Inco.

INSTALLATION DATA

INSTALLATION
59th Street Power Plant
New York City Transit System.

MANUFACTURER
Foster Wheeler Corporation
165 Broadway, N. Y. C.

SPECIFICATIONS
Burns and Roe, Inc.
233 Broadway, New York 7, N. Y.

TUBE DETAILS
Each heater has 550 Monel U-tubes, ⅝" O.D., 17 B.W.G. (.058" wall).

LOCATION
Two of the illustrated, closed-type, Monel-tubed feed-water heaters will be installed between boiler feed pump and boiler. (Three direct contact heaters are in the line before the feed pump.)

OPERATING CONDITIONS
950° F., 1250 psi at turbine throttle.

FIRST-STAGE MONEL-TUBED HEATER
Uses 450 psi, 680° F. bleed steam in shell. Outlet water temperature: 421.4° F.

SECOND-STAGE MONEL-TUBED HEATER
Uses 900 psi, 860° F. bleed steam in shell. Outlet water temperature: 515.1° F.

WATER PRESSURE IN HEATER TUBES
2000 psi design.

WATER VELOCITY THROUGH HEATER TUBES
3.97 feet per second.

CAPACITY OF HEATERS
693,000 pounds of water per hour.

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bine pumps, regenerative pumps and rotary pumps follow this same general outline.

On reciprocating pumps, construction characteristics of steam and power pumps, details of valves, piston rods, plunger packing and other construction items are given.

A chapter discusses installation and operation of reciprocating pumps and another gives remedies for steam and power pump troubles.

This is an up-to-date and very practical book for power engineers, written clearly and simply.

• • •

Radiant Heating, by T. Napier Adlam. Second Edition; 504 pages; illustrated; size 6 by 9 in.; cloth binding; published by The Industrial Press, 148 Lafayette Street, New York 13, N. Y. Price $6.00.

When the first edition of this book was published in 1947, it received a cordial reception in the engineering field for it embodied practically all that was known about the subject up to that time. The second edition of the book includes the newest developments since that time and incorporates the results of more than 30 years of experience by the author in radiant heating, radiant cooling and extensive studies in snow melting. It covers important developments both in the United States and Europe.

In the second edition, material has been added to the chapter on ceiling panels to include enclosed convector panels, gravity warm air panels and forced warm air panels. The chapter on floor panels has been increased to cover research on the physiological aspects of heated floors.

The chapter on walls, metal panels and electrical conductors has been increased to cover important developments in electrical rubber panels, portable electric screens, and radiant glass panels. Additional data on embedding electric conductors in the plaster of ceilings and walls to form heating panels are also provided.

The chapter on snow melting has been increased in size to include practical information for those who plan to design snow melting systems.

The book includes 78 working charts for direct determination of the pipe sizing necessary, covering both iron or steel pipe and copper tubing. Charts added to those in the first edition cover single or double wood floors, carpeting and felt pads on wood floors and painted steel wall panel.

The general treatment has been carried out with a minimum of mathematical calculation, many of the data being shown on curves and tables. These simplify the step-by-step procedure in the design of many components of radiant heating systems, and the design procedure is easy to follow. The book is well indexed.

• • •

The Watts Bar Project, Technical Report No. 9, by the TVA; 545 pages; illustrated; size 6 by 9 in.; cloth binding; published by the Tennessee Valley Authority. Procurable from the Treasurer's Office, Tennessee Valley Authority, Knoxville, Tenn. Price $2.00.

This is a different book from the one describing the Watts Bar Steam Plant previously noted in these columns. This book covers the entire Watts Bar Project on the Tennessee River ,iving complete data on the planning, esign, construction and initial operation of the project.

Besides the importance of the Watts Bar Project in the overall TVA system operations, its layout, design and construction involve problems and methods of particular interest to engineers engaged in similar river control work.

The report covers in detail preliminary investigations for the project including geology and river flow; dam and powerhouse design; construction methods, including construction plant; river diversion and access facilities; relocation and adjustments; initial operations; and a complete summary of the project costs. Appendixes include a complete statistical summary of the physical features of the project; reports of the engineering and geologic consultants; summaries of special studies; and lists of major purchases and construction equipment. Bibliographies for each phase of the project are also included.

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Refractories, 272 pages; size 9 by 11 in.; illustrated; cloth binding; published by the General Refractories Co., 1520 Locust Street, Philadelphia, Pa. Price $5.00.

This book supplies the little publicized but large and very important refractories field with a handbook of complete, accurate and up-to-date information. It is intended to serve those who design, use, purchase, construct and supervise the operation of equipment requiring refractory materials.

It describes the manufacture of refractory brick, tells what industries use refractories, where and why, and provides a guide to selection of the refractories best suited for each use. The company's complete line of refractory brick, mortars, plastics and castables is described.

A section of the book lists, pictures, and gives dimensions of all standard refractory brick sizes and shapes. Another deals with the properties and behavior of refractories.

For engineers and architects who design and build equipment that requires refractories, there is a great deal of information on construction with refractories as well as tables that simplify the calculation of numbers and types of brick needed. The glossary defines, in some cases for the first time in print, the meanings of many terms used in this industry, and a complete index at the back facilitates reference to any desired information.

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Methods of Joining Pipe, by J. E. York. First Edition; 236 pages; illustrated; size 5½ by 8½ in.; cloth binding; published by The Industrial Press, 148 Lafayette Street, New York 13, N. Y.

For all power engineers, whether designers, operating men or construction and maintenance men, here is a book that has been much needed for a long time. It describes and illustrates most of the known methods of joining pipes and gives instructions on just how to do it. The drawings of details illustrating these points are particularly good, for they really show the details that appear in the actual piping joints as the workman finds them in the plant.

This might be expected from the author, who is Building Service Engineer for Stone & Webster Engineering Corp., and obviously in close touch with all modern practice in handling piping. Before an engineer can design or a contractor or a workman can install a satisfactory piping system, they must have a thorough understanding of the pipe joints that are available.

Since no joint is generally suitable for all applications, it is helpful to have information regarding the advantages and disadvantages of each type so that the proper joint may be specified and the author has provided a good deal of this information.

In addition to discussing the proper basic selection of pipe material for the purpose at hand, the author treats the influencing factors in choosing a suitable pipe joint, such as: service for which the line is designed, temperature and pressure conditions, pipe size and pipe location, labor available for the joint and for servicing after the joint is installed, installation and maintenance costs and ability to repair the joint without shutting down the system.

The book illustrates and describes all types of pipe joints, including expansion joints, and effectively discusses proper selection of joints based on intelligent consideration of the above factors, and for both metallic and non-metallic piping. In a word, here's a book packed with information you can use on the job every day.

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Elements of Thermodynamics and Heat Transfer, by Edward F. Obert. First Edition; 372 pages; illustrated; size 6 by 9 in.; cloth binding; published by McGraw-Hill Book Co., 330 West 42nd St., New York 18, N. Y. Price $4.50.

Designed primarily as a textbook for the undergraduate course in thermodynamics and heat transfer for students of engineering, this book nevertheless should prove most interesting and useful to practicing engineers. The author has attempted to make the presentation simple and direct without sacrificing rigor or the emphasis on the fundamental aspects and continuity of the science. In our opinion, he has succeeded very well in doing this because these subjects are not easy, no matter how they are approached.

Believing that most students fail to understand thermodynamics because they get confused by the number of concepts and equations usually presented in the first few pages of a textbook, the author begins by presenting first the definitions that form the foundation of the subject. From this foundation arises the First Law, the principle of reversibility and then the Second Law. Upon this framework, the author has based the secondary phases. Properties of real fluids; characteristics of real gases, and the concept of the perfect gas. The applications of thermodynamics then follow.

Since the practicing engineer is called upon to deal with practical problem of fluid flow, the underlying principles and theories of flow have been emphasized. For the same reason, the allied subject of heat transfer is surveyed in the latter part of the book.

The author refers his discussion continually to real machines, real flow processes and real properties of fluids. The book is well illustrated with diagrams and sketches. Problems to be worked out are presented at the end of each chapter. Steam and various vapor tables of properties are included, and a number of folded charts in the back of the book show temperature, entropy, enthalpy and pressure relations for carbon dioxide, methyl chloride and the like, also a practical size Mollier Diagram.

• • •

How to Talk More Effectively, by Jean Bordeaux. 218 pages; illustrated; size 5½ by 8½ in.; cloth binding; published by The American Technical Society, Drexel Ave. at 58th Street, Chicago 37, Ill. Price $2.75.

By all odds this is one of the most up to date and effective discussions of the subject we have seen yet. Every power engineer will benefit greatly by reading it, even though he already knows how to talk effectively.

All the reasons why men must learn to do this have been discussed so many times that we shall not mention them here. This book reviews them very well in its first chapter, Leaders Must Speak Effectively. It then goes on to explain the influence of personality and the quality of your speech in producing the effect you want when addressing an audience.

The book is definitely up to date, as proved by the fact that it includes discussion of microphone technique (the microphone, incidentally, is not a megaphone), of town meeting and panel type techniques, and an especially good chapter on how to use the telephone.

The author tells you how to introduce speakers at a meeting, how to persuade without furious and futile argument, how to leave your audience laughing, how to interview somebody and how to be interviewed.

Among the most important parts of the book are the chapters on how you are selling all the time.

The author emphasizes, all the way through, the relation between what you say and how you say it, for the two are components of the same thing. He cannot, of course, tell you what it is you have to say but this falls into certain very general categories, and the author can give you a great deal of help on the assumption that you do have something to say. We heartily recommend this book to every reader of POWER GENERATION.

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Composition for Technical Students, by J. D. Thomas; 460 pages; size 5½ by 8½ in.; cloth binding; published by Charles Scribner's Sons, 597 Fifth Ave., New York 17, N. Y. Price $3.75.

This book opens with a discussion of technical English, British and American English, what constitutes good English, and the various technical vocabularies and styles. Next is a division called Handbook of Fundamentals, dealing with problems of grammar, diction, punctuation and mechanical form in technical matter. Another section deals with the major objective of technical language—to explain things—and what the author calls the minor functions of technical discourse: description, narration and argumentation. The last part of the book covers forms of technical communication, including letter writing, library research, the technical report and the technical speech.

Several appendixes contain exercises and a number of readings from engineering literature and about engineering.

• • •

Papers Presented at 42nd Annual Meeting, Smoke Prevention Association of America; 190 pages; illustrated; size 8½ by 11 in.; paper binding; published by John Paul Taylor, 520 Pleasant St., St. Joseph, Michigan. Price $2.00.

This new book contains the most recent smoke prevention information as brought out at the 1949 Annual Meeting of the Smoke Prevention Association of America, Inc. It contains 23 articles with 22 illustrations, and the papers are by consulting engineers, industrial engineers, smoke inspectors, equipment manufacturers and others.

They cover Health Aspects of Air Pollution; Smoke and Fumes Abatement in the Oil Industry; Hot Gases from High Stacks; Annual Inspection of Fuel-Burning Equipment; Comparison of ASME Code for Smoke Emission with Codes of Cities and many other aspects of smoke prevention activities.

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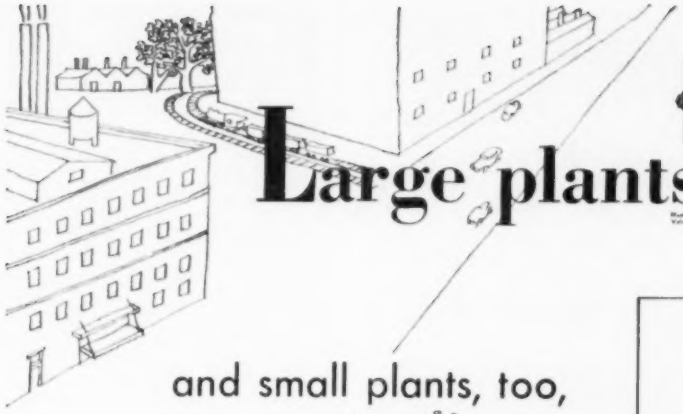
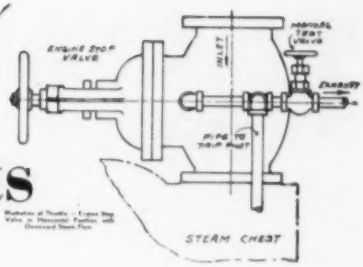
Review of Current Research and Directory of Member Institutions, by Engineering College Research Council; 180 pages; size 6 by 9 in.; paper binding; published by Engineering College Research Council of the American Society for Engineering



Large plants



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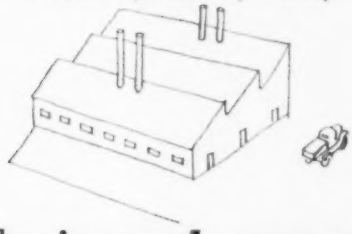

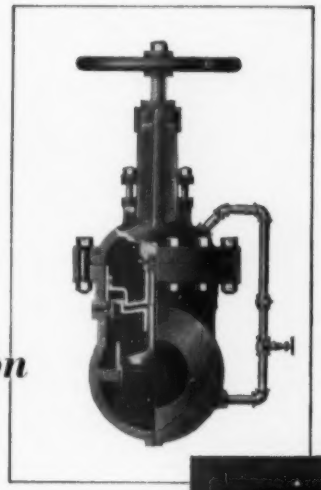

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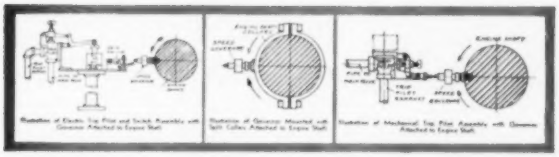

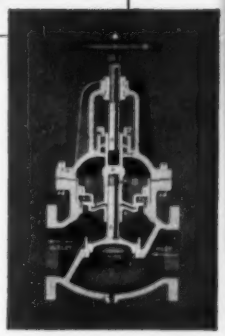

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Education. Address orders to F. M. Dawson, Chairman, c/o College of Engineering, State University of Iowa, Iowa City, Iowa. Price $1.75.

Over 4000 current college and university research projects in engineering, representing expenditures of over $35,000,000, are listed by title in the 1949 Review of Current Research.

Entries in this book from 82 educational institutions which hold membership in the Research Council, describe the administrative policies for conducting engineering research and list the responsible personnel, research expenditures, short courses and conferences of special interest, and the titles of all engineering research studies active at present at each institution. There is a complete index to research project subjects and the projects are broken down according to the engineering departments involved.

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Use of Tools, prepared by Standards and Curriculum Division, Training, Bureau of Naval Personnel, U. S. Navy. 258 pages; illustrated; size 5 by 8 in.; paper binding; obtainable from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 65 cents.

This book was prepared as a basic reference for those enlisted men of the Navy whose duties require them to use tools to keep Navy gear and equipment in shipshape condition. It covers hand tools and small power tools but not machine tools.

Since the use of hand tools with which to fashion a finished product from some material such as wood, metal, clay, stone and so on, is fundamental in every part of engineering, many engineers feel that no man really merits the title unless, at some time in his life, he has learned to use hand tools properly and effectively, so that he will get the "feeling" of them. Some engineers even go so far as to say that unless engineers can really feel the thrill that comes from creating something themselves with hand tools, they cannot really have the feeling for engineering. That point is, of course, debatable. Nevertheless, there is something in most men that is satisfied by the use of tools of some sort.

However, in engineering work, and especially in the work of technicians such as those the Navy is addressing here, certain techniques in handling tools must be learned whether the user likes it or not.

Even though one has many tools and is skilled in their use, he will still get a great deal out of this book and it will be a useful reference in instructing others.

The book begins with advice on the use of such general purpose tools as hammers, screwdrivers, pliers, punches and wrenches. It explains the use of the tools used for cutting and shaping metal, such as hacksaws and snips. Chapters are devoted to threading tools, pipe and tubing tools, woodworking tools, measuring tools, gages and indicators, soldering and welding tools, special tools, metal fastening devices and abrasives. The illustrations showing the proper method of handling various tools are particularly well done.

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Numerical Analysis of Heat Flow, by G. M. Dusinberre; First Edition; 226 pages; illustrated; size 6 by 9 in.; cloth binding; published by McGraw-Hill Book Company, 330 W. 42nd St., New York 18, N. Y. Price $4.50.

The author of this book, professor of mechanical engineering at The Pennsylvania State College, explains that it is not adapted to casual reading. In writing it, he has assumed that the reader has a job to do—namely to analyze a given flow of heat—and that he wants to learn a new and better way of doing it. The author offers a "tool" that will require some study and practice before it is useful to the owner, but, having mastered it, the reader will find it is useful in many fields of engineering and physics.

The method is, in short, the numerical calculation of heat flow by the use of arithmetic—addition, multiplication and division. A work sheet of a numerical solution may become a maze of figures and at first glance may appear complicated, but the secret lies in getting it properly organized.

The material presented here has previously been scattered in the literature in the form of condensed technical papers generally useful only to one already expert in the field. The author has collected these methods and presented them in a sequence of graded difficulty. Much of the theory is original with the author and some of it has never appeared before. The book presents a variety of techniques, and problems are presented giving examples of various combinations.

The subjects treated are: first, thermal properties, elementary combinations and analytical solutions. Then the author takes up steady state, physical subdivision, some alternative methods, a multidimensional system and steady state geometrical systems, one dimension. This is followed by a discussion of two-dimensional square networks, two-dimension networks other than square, transient flow, variable properties and so on. There is an extensive bibliography and the book is well indexed.

It is important to emphasize that this book is talking about actual practical problems in such things as heating of a building, calculations in heat pump design, use of insulation, flow of fluids or molten solids and the like, and that the methods described here lead to real numerical results in terms of Btu, degrees Fahrenheit temperature, size of pipe, and so on. The methods are free from the limitations of conventional differential analysis, and permit solution of many problems not otherwise possible except by costly experiment.

It is true that relatively few engineers in practice need to calculate heat flow in the most minute detail; yet somebody, somewhere, must do it, and every power engineer should have some knowledge of how he can attack the problem, if he is ever called upon to do so.

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Report on Oil Engine Power Cost for 1948, by the ASME; 44 pages; illustrated; size 8½ by 11 in.; paper binding; published by The American Society of Mechanical Engineers, 29 W. 39th Street, New York 18. Price $2.50 (20 per cent discount to ASME members).

Once again the Subcommittee on Oil-Engine Power Costs, Oil and Gas Div. of the ASME, has issued its regular report for 1948, the latest in the valuable series on this subject.

This report, like its predecessor, presents information on performance and production costs of oil-engine power plants. The report includes information from 124 oil engine generating plants containing 441 engines, totaling 432,493 rated brake horsepower. The total net output from these plants amounted to 721,270,430 kwhr. Individual plants are designated only by numbers.

The book is divided into three main sections, tabular in form. Table I gives information on production costs; Table II shows comparative cost for the years from 1929 to 1948, and Table III tabulates engine details and operating information. Numbers identifying plants previously reported correspond to the same plant in this report.

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Engineers' Dictionary. Spanish-English and English-Spanish, by L. A. Robb; Second Edition; 664 pages; size 5½ by 8½ in.; cloth binding; published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $12.00.

The objective of this dictionary is to give the North American technical man the accepted engineering terminology of Spanish America and vice versa. This is the second edition of a work issued originally in 1943. It has now been much expanded to cover electrical and mechanical engineering more thoroughly, bring all branches of civil engineering up to date, and include important terms in mining, shipbuilding, logging and several other fields.

A new feature is the notation of gender with all Spanish nouns.

In an interesting preface, the author discusses some of the problems of technology and language that arise in compiling such a dictionary. Listing of machine parts calls for the constant use of judgment because every manufacturer has his own list of parts and some machines have parts running into the thousands.

The book is not intended to define such things as a slipring motor but to give the accepted Spanish equivalent of that term. Where several meanings may be given to a word, both in Spanish and English, the non-technical meanings have usually been ignored.

Spanish equivalents of English trade names are a problem. The simple statement that proprietary names cannot be translated does not cover the situation, because they are regularly being translated in Spanish-speaking countries. The author's rule has been to include every term of this kind that he has found in good technical use in both countries.

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Heat Power Fundamentals, by Carroll M. Leonard and Vladimir L. Maleev; 596 pages; illustrated; size 6 by 9 in.; cloth binding; published by Pitman Publishing Corp., 2 West 45th St., New York. Price $5.75.

This new book on heat power fundamentals has a number of interesting features and although it is intended primarily as a textbook for students taking a first course in heat power engineering, it should prove useful to engineers. For the most part, it is not too mathematical. The discussion begins, not with thermodynamic theory, but with a discussion of the steam power plant as a unit, treating both industrial and central stations and showing illustrations of really modern stations, such as Mystic and Sewaren.

This is followed by a discussion of the fundamentals of thermodynamics compressed to one chapter, then a chapter on steam.

Following this, the book covers steam engines and turbines, condensing equipment, heating and pumping, boilers and superheaters, fuels and combustion, fuel burning equipment, the internal combustion engine, the gas turbine and refrigeration.

Of particular value is the selection of problems after each chapter, also the list of references for collateral reading. These references are all made to up to date textbooks and recent articles in the technical press, and they certainly should be read in connection with the text.

There is a very good and interesting chapter on vapor cycles, following the discussion of the various units that make up the modern power plant. This discusses variations from the ideal cycle, shows the advantages of the reheat cycle, and the regenerative cycle, also the mercury vapor and other binary cycles.

Conversion of existing power plants to take advantage of developments, and variations in plant design, are touched on briefly and that is probably all that can be done in a book intended for undergraduates. Yet it should be pointed out that this problem of variation and also of keeping step with power plant practice in actual power plants will confront the undergraduate very soon after he leaves college and involves many economic as well as engineering considerations. It deserves a book of its own.

A good chapter is devoted to internal combustion engines and the chapter on the gas turbine plant is accurate and up to date, including data on the 3500 kw Oklahoma installation that went into operation last year, as described in this magazine.

The final chapter covers the fundamental principles of mechanical refrigeration.

At the end of the book are steam tables, pipe tables and a large folded Mollier Diagram. The book is well indexed.

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Plain Concrete, by Edward E. Bauer; 422 pages; plus 3 appendixes, and an index; size 6 by 9 in.; cloth bound; third edition; 1949. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 18, N. Y. Price $5.00.

This is a textbook used by the author, associate professor of civil engineering at the University of Illinois. The second edition appeared in 1936. This new edition covers significant developmets that have occurred during the intervening period.

Among others, there is a complete treatment of plain concrete, the use of which is rapidly increasing, a chapter on high-alkaline cements, which react unfavorably with certain siliceous aggregates, and important changes in specifications and testing techniques.

The book is divided into 14 chapters covering all phases of standard and special cements, aggregates, mixture proportioning, pouring and curing and field control. There are also chapters discussing factors affecting the strength of concrete, flexibility, workability, water-proofing, specifications, sampling and testing.

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The Story of Magnesium, by W. H. Gross. 258 pages; size 5 by 8 in.; cloth bound; 1949. published by the American Society for Metals, 7301 Euclid Avenue, Cleveland 3, Ohio. Price $2.00.

World War II emphasized the importance of magnesium as one of the basic industrial metals. This book covers the story of its development, use, production and properties in a very readable style. It is intended for the layman rather than the technician, but is by no means a popular book. It deals with the economic factors involved, the properties of magnesium and its typical use in many different ways in industry. The book might be called "a non-technical manual" on the production, utilization and properties of magnesium.

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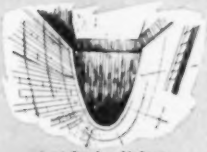
Installation and Maintenance of Electric Supply and Communication Lines. 372 pages plus index; cloth bound; size 5 by 8 in.; 1949. Published as National Bureau of Standards Handbook H43, and for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price $1.50.

This new handbook contains definitions, grounding rules, and part 2 of the fifth edition of the National Electrical Safety Code, dealing with the construction and maintenance of overhead and underground lines. It was originally published as Handbook

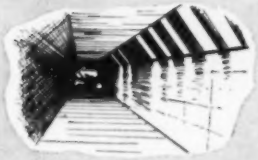
WHERE TO USE LUMNITE IN POWER PLANTS

Steel Stack Linings

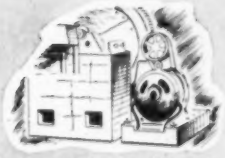
Ash Pit and Cinder Catcher Linings



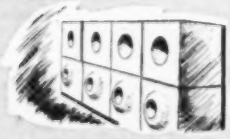
Coal Bunker Linings



Flue and Duct Linings



Overnight Structural Concrete



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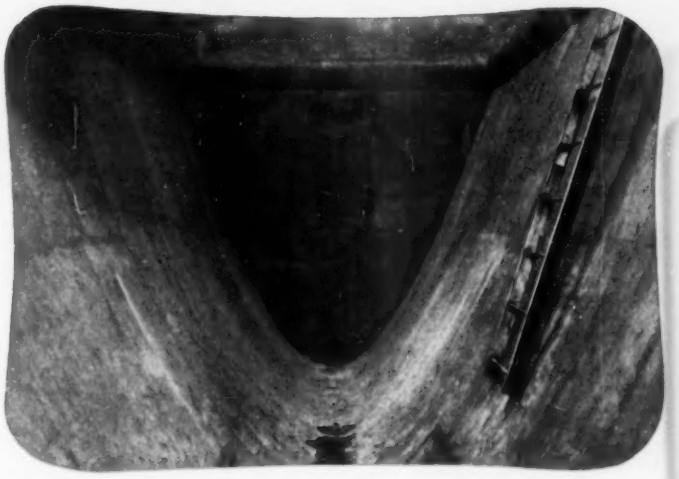

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H32, together with the discussion of the grounding rules, and Part 2 of the code was originally published as Handbook H39. Data in the appendices cover information useful in making computations for strength, supporting structures, and determining crossing clearances. In some instances, engineering short cuts are suggested.

NEWS *from* THE FIELD

12th MIDWEST POWER CONFERENCE TO BE HELD APRIL 5-6-7, 1950

THREE-DAY meeting of the Midwest Power Conference, centered around the theme "Economy in Power," will be held at the Sherman Hotel in Chicago on April 5, 6 and 7, 1950. A total of 26 sessions including 3 luncheons and the All-Engineer's Dinner are scheduled for the program. More than 50 papers will be presented by leading authorities in practically every phase of the power industry.

The conference is sponsored by the Illinois Institute of Technology in cooperation with nine Midwestern Universities and nine local and National engineering societies. A cordial invitation to attend is extended to all persons interested in the nation's power problems.

For further information concerning the conference, write to R. A. Budenholzer, conference director, or Edwin R. Whitehead, conference secretary, Illinois Institute of Technology, Technology Center, Chicago 16, Illinois.

PRELIMINARY PROGRAM 12th MIDWEST POWER CONFERENCE

April 5-6-7, 1950
Sherman Hotel, Chicago

Wednesday, April 5, 1950

8:30 A.M. Registration, Sherman Hotel.

10:30 A.M. Opening Meeting.

12:15 P.M. Joint Luncheon with A.S.M.E.

2:00 P.M. Steam Generation Equipment. Chairman: E. C. Bailey, Chairman, Power and Fuels Division, Chicago Section, A.S.M.E.

(Sponsored and arranged by Power and Fuels Division, Chicago Section, A.S.M.E.)

(a) Use of Model to Study Steam Separation in Boilers. Erich Farber, University of Wisconsin.

(b) The Dual Circulation Boiler. R. A. Lorentzen, Foster Wheeler Corp.

2:00 P.M. Electrical Equipment. Chairman: E. T. B. Gross, Illinois Institute of Technology.

(a) An Appraisal of Power Transformer Design Progress. W. Gordon James, Manager, Larger Power Transformer Design Section, Westinghouse Electric Corp.

(b) Modern Type High-Power Circuit Breakers. Robert H. Nau, Department of Electrical Engineering, University of Illinois.

3:30 P.M. Feedwater Treatment No. 1. Chairman, M. P. Cleghorn, Iowa State College.

(a) Demineralization Compared with Evaporation of Make Up for High Pressure Condensing Power Plants. J. D. Yoder, Vice President, The Permutit Co.

(b) Applying Steam Lift Circulation to Hot Process Softeners and Deaerators. A. A. Kalinske, Director of Development, and J. M. Kahn, Chemical Engineer, Infilco Inc.

3:30 P.M. Fuels. Chairman: M. A. Faucett, University of Illinois.

(a) Coal's Place in the Sun. Bertrand A. Landry, Supervisor, Fuels Division, Battelle Memorial Institute.

(b) Industrial Fuels from Oil-Shale. Boyd Guthrie, Chief, Oil-Shale Demonstration Plant.

3:30 P.M. System Planning and Design. Chairman: E. B. Kurtz, State University of Iowa.

(a) Circuit Interruption by Means of High Voltage Air Switches (with film). S. C. Killian, Chief Engineer, Delta Star Electric Co.

(b) Safety in Substation Design. J. O. Leslie, Director of Safety, and D. L. Greene, Electrical Engineer, Gilbert Associates, Inc.

Thursday, April 6, 1950

9:00 A.M.—12:00 Noon. Feedwater Treatment No. 2. Symposium on Magnetic Iron Oxide Deposits. Chairman: R. T. Hanlon, National Aluminate Corporation.

(Sponsored by the Joint Committee on Boiler Feedwater Studies.)

(a) Experimental Studies of Iron Oxide Deposits in Boilers. C. Jaklin, Assistant Director of Engineering Research, and W. H. Thompson, Director of Service, National Aluminate Corp.

(b) Steel, Heat and Water: Localized Formation of Magnetic Iron Oxide in Power Boilers. H. M. Rivers, Service Engineer, and W. M. Sonnett, Research Engineer, Hall Laboratories, Inc.

(c) Magnetic Iron Oxide Deposits in a 420 psi Boiler. J. H. Moore, General Plant Superintendent, Otter Tail Power Co.

(d) Causes and Prevention of Iron Oxide in Boilers. S. T. Powell, L. G. von Lossberg, and J. K. Rummel, Sheppard T. Powell Chemical Engineers.

(e) Prevention of Black Iron Oxide Deposits Following Chemical Cleaning. P. H. Cardwell, Chief Chemist, Dowell Inc.

9:00 A.M. Power System Operation. Chairman: V. I. Easterday, Chairman, Power Group, Chicago Section, A.I.E.E.

(Sponsored and arranged by Power Group, Chicago Section A.I.E.E.)

(a) Control of Power Flow on Interconnected Systems. Nathan Cohn, District Manager, Technical Sales, Leeds & Northrup Company.

(b) What Reserves Should Be Provided in a Modern Power System? Howard P. Seelye, Chief Engineer, The Detroit Edison Co.

10:30 A.M. General Session on Rural Electrification. Chairman: E. W. Kimbark, Northwestern University.

(a) A New Approach in Utility Cooperation with R.E.A. John M. Drabelle, Iowa Electric Light and Power Co.

(b) Cooperation Between Electric Companies and Cooperatives. Edwin Vennard, Vice President, Middle West Service Co.

12:15 P.M. Joint Luncheon with A.I.E.E. Chairman: H. E. Nason, Chairman, Chicago Section, A.I.E.E.

Speaker: J. H. Jewell, Vice President in Charge of Sales, Westinghouse Electric Corp.

2:00 P.M. Central Station Plants. Chairman: R. C. Porter, University of Michigan.

(a) Recent Improvements in Central Station Equipment. G. A. Gaffert, Partner, Sargent & Lundy, Engineers.

(b) Modern Steam Turbine Developments. J. R. Carlson, Manager, Steam Application Engineering Department, Westinghouse Electric Corp.

2:00 P.M. Small Power Plants. Chairman: Glen E. Copeland, Minneapolis State Capitol Bldg., St. Paul, Minn.

(a) Comparative Costs of Fabrication of Industrial Piping. Charles Schott, Chief Engineer, Frank Fehr Brewing Co.

(b) Power Plant Operating Costs. Jules Brunner, The Glidden Co.

2:00 P.M. Industrial Applications of Electrical Energy. Chairman: H. L. Decker, Chairman, Industrial Group, Chicago Section A.I.E.E.

(Sponsored and arranged by Industrial Group, Chicago Section A.I.E.E.)

(a) Conversion of Electrical Energy by Mechanical Means. Otto Jensen, Manager, Restifier Division, I-T-E Circuit Breaker Co.

(b) Electric Power Distribution Systems for Typical Industrial Plants. S. L. Chapin, Electrical Engineer, Sargent & Lundy, Engineers.

3:30 P.M. Electronics Application. Chairman: H. J. McCreary, Chairman, Electronics Group, Chicago Section A.I.E.E.

(Sponsored and arranged by Electronics Group, Chicago Section A.I.E.E.)

(a) Factors Affecting the Use of Electronic Instruments by the Power Industry. George E. Foster, Chief Engineer, Metrotype Corp.

(b) Electronic Loading for Boiler Control. Charles Smoot, Jr., Republic Flow Meters Co.

3:30 P.M. Power Plant Design and Construction. Chairman: Ben G. Elliott, University of Wisconsin.

(a) Trends in Power Plant Design and Construction. Paul Gordon, Chief Mechanical Engineer, Ebasco Services Inc.

(b) Basic Factors in Steam Station Design. B. C. Mallory, Chief Mechanical Engineer, Stone and Webster Engineering Corp.

3:30 P.M. Miscellaneous Steam Applications. Chairman: Dean L. G. Miller, Michigan State College.

(a) Feedwater Heating and Deaeration. A. E. Kittredge, Cochrane Corp.

(b) Steam Services from Central Station Districts. Glenn D. Winans, Assistant Superintendent of Central Heating, The Detroit Edison Co.

6:30 P.M. All Engineers Dinner. Informal.
Grand Ball Room. (Ladies Invited.)

Friday, April 7, 1950

9:00 A.M.-12:00 Noon. Symposium on Atmospheric Pollution. Chairman: Louis C. McCabe, Chief, Office of Air and Stream Pollution Prevention Research, U.S. Department of the Interior, Bureau of Mines.

(a) (Subject to be announced.) Frank A. Chambers, Chief Smoke Inspector, Department of Smoke Abatement and Inspection, Chicago.

(b) Technical Aspects of Air Pollution Abatement. A. D. Singh, President, Singh Co.

(d) Smoke Abatement Engineering. H. B. Lammers, Chairman, Coal Producers Committee for Smoke Abatement.

(e) Field and Laboratory Methods of Air Pollution Study. Paul L. Magill, Supervisor, Air and Water Pollution Laboratory, Stanford Research Institute.

9:00 A.M.-12:00 Noon. Panel Discussion on Diesel Engine Maintenance. Chairman: W. P. Green, Illinois Institute of Technology.

(Sponsored by Diesel Engine Manufacturers Association.)

In addition to stating maintenance problems and the more common methods used in solving them, recent laboratory techniques in this field will be discussed.

(a) D. H. Queeney, General Service

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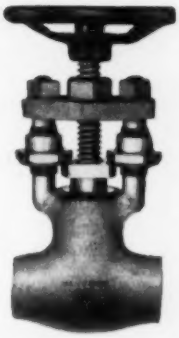

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Manager, Electro-Motive Division, General Motors Corp.
(b) Raymond McBrian, Vice President, Denver and Rio Grande Western Railroad Co.
(c) James E. Justus, Manager, Diesel Locomotive Service, Fairbanks Morse and Co.

9:00 A.M. The Heat Pump. Chairman: J. W. Andeen, University of Minnesota.
(a) Standards of Performance for Heat Pump Cycles. John F. Sandfort, Associate Professor of Mechanical Engineering, Iowa State College.
(b) Earth Heat Pump Research. Estel B. Penrod, Head, Department of Mechanical Engineering, University of Kentucky.

10:30 A.M. Heating and Air Conditioning. Chairman: J. D. Pierce, Research Supervisor, Crane Co.
(a) Heating of Basementless Houses with Warm Air. C. W. Nessell, Minneapolis-Honeywell Regulating Co.
(b) Development of Turbine Driven Centrifugal Refrigeration Machines and the Water Absorption Machine. O. E. Gammill, Jr., Product Manager, Heavy Machinery, Carrier Corp.

12:15 P.M. Joint Luncheon with W.S.E.

2:00 P.M.-5:00 P.M. Gas Turbine Locomotives. Chairman: J. T. Rettaliata, Illinois Institute of Technology.
(a) A 4000 hp Gas Turbine Locomotive for Passenger Service. T. J. Putz, Manager Locomotive and Gas Turbine Engineering, Westinghouse Electric Corp.
(b) A Coal Burning Gas Turbine for Locomotive Service. W. B. Tucker, Turbo Power Devel. Dept., Allis-Chalmers Manufacturing Co.
(c) Progress Report of Coal Burning Gas Turbine Locomotive. J. I. Yellott, Director of Research, Locomotive Development Committee.

2:00 P.M. Feedwater Treatment (Sponsored by the Chicago Section A.S.M.E.)
(a) Water Treatment for Modern Electric Utility Plant Installations. F. G. Straub, Research Professor of Chemical Engineering, University of Illinois.
(b) Prevention of Deposits in Closed Feedwater Heaters and Economizers. Warren S. Kane, Iowa Public Service Co.

2:00 P.M. Relay Testing Practices. Chairman: E. L. Michelson, Commonwealth Edison Co.
(a) Relay Maintenance in a Metropolitan Power System. J. W. Smith, Commonwealth Edison Co.
(b) Relay Testing Practices in a Power Company Serving a Large Area. V. E. Verral, Central Illinois Public Service Co.

WILLIAM F. RYAN

Stone & Webster Engineering Corp. announces the election by its Board of Directors of William F. Ryan as Vice President of the Corporation.

Mr. Ryan, broadly experienced in the power, industrial and chemical engineering fields, joined the organization in 1929 as a mechanical engineer, subsequently being responsible for the design of several heavy chemical plants and a number of steam power stations for public utility and industrial clients. He became Assistant Chief Mechanical Engineer in 1941, Assistant Engineering Manager in 1945, and Engineering Manager in 1948. As Engineering Manager, he will continue to be responsible for the activities of the Engineering Department with his headquarters in the Boston office.

William F. Ryan

PAUL R. DUFFEY ELECTED FELLOW OF ASME

Paul R. Duffey, power engineer, Youngstown Sheet and Tube Co., Youngstown, Ohio, has been elected a fellow of the American Society of Mechanical Engineers. The award was bestowed upon him, at a meeting of the Youngstown Section of ASME on November 10, 1949, by Region V Vice President, Thomas E. Purcell and C. C. Womack, Sr., chairman of the Youngstown Section executive committee.

Election to ASME Fellow is a distinction bestowed on an outstanding member of acknowledged engineering attainment, who has had 25 years of active professional practice and been an active member of the Society for 13 years. Ever since the end of World War I, Mr. Duffey has specialized in industrial power plant engineering and has been a leader in development of high-pressure, high-temperature industrial power plants. He is well known to readers of Power Generation, under its former title Power Plant Engineering, for his outstanding technical articles

Paul R. Duffey

on industrial power plant design and operation. He is active in national and local ASME section activities and with a small group was responsible for the re-activation of the Youngstown Section in 1948. He is active in community affairs and an active member of the Ohio Society and of NSPE.

A native of Roanoke, Va., Mr. Duffey received his education at Virginia Polytechnic Institute and University of Cincinnati, earning his college expenses as a part-time mechanical supervisor and power plant engineer for the Norfolk and Western Railway Co. During World War I he was superintendent of Steam and Electric Power Generation, Potomac District U. S. Railroad Administration.

He joined Youngstown Sheet and Tube Co. in 1940 as a special mechanical power engineer on the staff of the chief engineer. Under the late Fred E. Norton, he worked on operating problems at Indiana Harbor Works and on studies for a high-pressure unit there. After Mr. Norton's death, Mr. Duffey supervised design, construction and operation of such projects as the new steam generating stations at the South Chicago and Indiana Harbor Works, blast furnace blowers at Campbell and Indiana Harbor Works. At present he is planning construction of steam generating unit No. 7, to be the largest single steam generating unit in any Sheet & Tube generating plant.

The Industrial Department of the American Arch Company, Inc., New York, has been purchased by the M. H. Detrick Co. American Arch Division with offices in the Oliver Building, Pittsburgh, Pennsylvania.

H. S. Colby, formerly identified with the Riley Stoker Corporation, Worcester, Mass., and Combustion Engineering Co., Inc., New York, N. Y., has joined the Springfield Boiler Co., Springfield, Ill., as assistant to the president.

Following a shop and engineering apprenticeship with the Mosher Marine Boiler Co. prior to World War I, he started as an assistant foreman in the marine boiler shop of the Babcock & Wilcox Co. After the war, he became vice president of the United Machine & Mfg. Co., Canton, Ohio, subsequently consolidated with the Riley Stoker Corp., where he acted as assistant sales manager for several years.

After a brief period of sales work for the B. F. Sturtevant Co., Mr. Colby was made president of the Air Preheater Corp. After some five years, this company was consolidated with the Superheater Company, which controlled the Combustion Engineering Co., Inc., to which company he was assigned as general sales manager and he served in that capacity until the outbreak of World War II. He then returned to shop operation and, as a divisional vice president of Baldwin Locomotive Works, was in charge of ordnance manufacture for the Army and Navy.

James P. Stewart, vice president and manager of commercial sales division, has been elected executive vice president of De Laval Steam Turbine Co., and will continue as Manager of the Commercial Sales Division.

Mr. Stewart came with the company in 1946 to handle the sales of its centrifugal compressors after seventeen years capital goods experience with the Elliott Company,

Jeanette, Pa., and Borg-Warner Corp., Milwaukee, Wis.

W. A. Reynolds, manager of the IMO-DE Laval Products Division, has been appointed assistant to the president.

Mr. W. A. Neumann, Jr. controller of the company, has been appointed acting manager of the IMO-De Laval Products Division, but will retain the title of controller.

Carl E. Miller has joined the engineering staff of the Industrial Department of Combustion Engineering-Superheater, Inc. Mr. Miller was formerly technical advisor in research and development on coal, gas, and petroleum technology at Battelle Memorial Institute and served as special consultant on fuels to the Economic Cooperation Administration in Europe.

An engineering graduate of the University of Cincinnati, Mr. Miller was associated 8 years with the Potomac Electric Power Co., for three years with the Northern Indiana Public Service Co. During World War II he served in the Office of the Chief of Engineers of the War Department as chief of the heating section and assistant chief of the utilities branch.

Mr. Miller has been active in AIM & ME and ASME, currently serves on the executive committee of the ASME Fuels Division of the latter society.

Phil Arnold, vice-president of The Garlock Packing Co., will voluntarily relinquish his duties and responsibilities in charge of the Company's general sales department on January 31, 1950. He will continue in a partially active capacity for an indefinite period as a vice-president of the company.

Mr. Arnold has been continuously associated with The Garlock Packing Company for more than forty-one years. He joined that company in 1908 as a sales representative. Subsequently he has served as manager of the railroad sales department, district sales manager at Cleveland, Ohio, and since July 1, 1929 as vice-president in charge of sales with offices at 2111 Terminal Tower, Cleveland.

Effective February 1, 1950, Louis Mohn is appointed general sales manager of the company with headquarters at Palmyra, New York. Also effective February 1, 1950, Eugene G. Flannery is appointed district manager at Pittsburgh to succeed Mr. Mohn.

Dr. Albert W. Hull, assistant director of the General Electric Research Laboratory, who has been credited with the invention of more types of electron tubes than any other man, retired recently.

One of the tubes invented by Dr. Hull was the magnetron, his basic invention having been made in 1921. Later it was modified and improved

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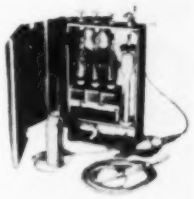

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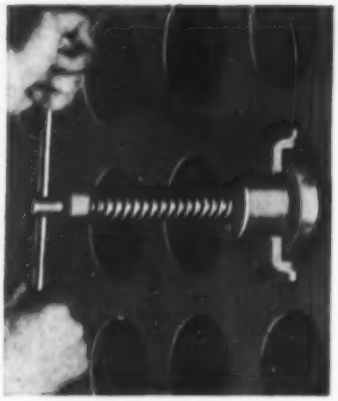

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If you operate any of the boilers listed below, you can't afford to be without a ROTO Hand-hole Seat Scrapper.

A Pennsylvania manufacturer reports that it formerly took three men 2 to 3 days to clean inside cap seats on a Keeler Boiler header. Now, with a ROTO Hand-hole Seat Scraper, one man does it in four hours, besides doing a better job.

This simple, hand-operated tool is equipped with retractable knives mounted on the end of a revolving spindle having a bearing in a substantial yoke. An adjustable spring automatically maintains tension on the knives, sufficient to remove all foreign matter but not enough to cut the metal. A few turns to the right, and the job is done. A half turn to the left releases the tool. Write for bulletin and prices.

MAKE OF BOILER	TUBE SIZE	OPENING
Babcock & Wilcox	4"	Oval
B. & W. No. 40 Header	3½"	Oval
B. & W. No. 41 Header	2"	Oval
B. & W. Superheater	2"	Round
Babcock & Wilcox	4½ x 5"	Square
Casey Hedges	4"	Oval
Casey Hedges	3½"	Oval
Combustion Engineer'g	3"	Round
Edge Moore	4"	Oval
Franklin	4"	Round
Geary	4"	Oval
Heine	3½"	Oval
Heine	3½"	Round
Keeler	4"	Round
Keeler	4"	Diamond
Murray	4"	Oval
Murray	3½"	Oval
Oil City	4"	Oval
Oil City	3½"	Oval
Union Iron Works	4"	Pear Shape
Welsh & Widener	4"	Oval

Roto Hand-hole Seat Scraper for Heine Boiler.

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by scientists in many countries, and during World War II formed the heart of short-wave radar. Magnetrons are now being applied for quick heating of plastics and other materials in many industrial processes.

He also made basic inventions in the screen-grid tube, which made possible modern radio and television receivers. The thyratron is another Hull invention. This tube, employed for automatic control of electric welding and many other industrial processes, is used in addition to regulate the lighting in Radio City Music Hall in New York. His latest invention, relating to the caesium rectifier for converting alternating to direct current, is not yet in commercial production.

Up to the first of this year Dr. Hull has been awarded 92 patents.

Dr. Hull was born at Southington, Conn., and att nded Yale University, graduating in 1905. Continuing in post-graduate studies, he received the Ph.D. from Yale in 1909. After this he taught physics, first as instructor, then assistant professor, at Worcester Polytechnic Institute, before he came to the G-E Research Laboratory in 1914 as a research physicist. In 1928 he was made assistant director of the laboratory.

Obituaries

FREDERIC N. BUSHNELL

FREDERIC N. BUSHNELL, 82, internationally known for his engineering accomplishments and in 1945 recipient of the New England Award of the Engineering Societies of New England, died in Brookline, Massachusetts, on January 23.

He was born in Saybrook, Conn., and undertook his engineering career by apprenticeship with the Providence Engineering Works in Providence, R. I., later becoming chief engineer. He later served as chief engineer with Narragansett Electric Lighting Co. in charge of all engineering, construction and power station operation, and at the same time was general manager of the Armington-Sims Engine Co., chief engineer of Rhode Island Co., and engineer for United Traction Co., Rhode Island Suburban Railway Co., East Providence Water Co., and Providence, Fall River & Newport Steamboat Co.

Mr. Bushnell joined the Stone & Webster organization in 1907 as chief engineer, became vice president of Stone & Webster Engineering Corp. in 1925 and vice chairman of its Board in 1929. He was retired in 1947 after more than 40 years of association with the Stone & Webster organization.

SAMUEL FERGUSON

SAMUEL FERGUSON, 75, chairman of the board of Hartford (Conn.) Electric Light Co., died Feb. 10 while vacationing at Lake Wales, Fla. Considered an expert on electric utility management and rates, Ferguson had been a frequent witness at Federal Power Commission hearings on rate cases and public vs. private power issues.

He was a past-president of the Association of Edison Illuminating Companies; a trustee of Edison Electric Institute, Western Massachusetts Companies, and Trinity College, his alma mater; and a director of Arrow-Hart & Hegeman Electric Co., three Hartford insurance companies, and other firms.

Ferguson, who also served as president of Connecticut Power Co., New London, started with General Electric Co. For 12 years he worked under the late Dr. Charles P. Steinmetz and W. R. Whitney, former director of the research laboratory, as a research engineer and consultant.

He joined the Hartford company in 1912 as vice-president and became president in 1924. In 1946 he retired to become chairman of the board. Under his leadership the company gained a reputation for pioneer developments in engineering, operating practice, and commercial and public relations policies.

FREDERIC ALAN SCHAFF

FREDERIC ALAN SCHAFF, chairman of the board of Combustion Engineering-Superheater, Inc., died at his home, 27 Masterton Road, Bronxville, New York, on Tuesday evening, at the age of 65, following a protracted illness.

Widely known in both railway and power fields, Mr. Schaff was an officer or director of numerous companies manufacturing equipment for both fields. These included, besides Combustion Engineering-Superheater, Inc., Lima-Hamilton Corp., director; The Lummus Co., chairman and director; The Superheater Co., president and director; American Throttle Co., president and director; The Air Preheater Corp., chairman and director; Franklin Railway Supply Co., director; Combustion Publishing Co., president and director; and foreign affiliates of several of the above companies.

Mr. Schaff attended Culver Military Academy and Purdue University from which he graduated in mechanical engineering in 1907. He was a member of Sigma Chi fraternity, and was elected to Tau Beta Pi, honorary engineering fraternity.

Mr. Schaff was a Fellow of the American Society of Mechanical Engineers and a member of The Newcomen Society, Academy of Political Science, Iron & Steel Institute, the Navy League of the U. S., Society of Naval Architects and Marine Engineers.

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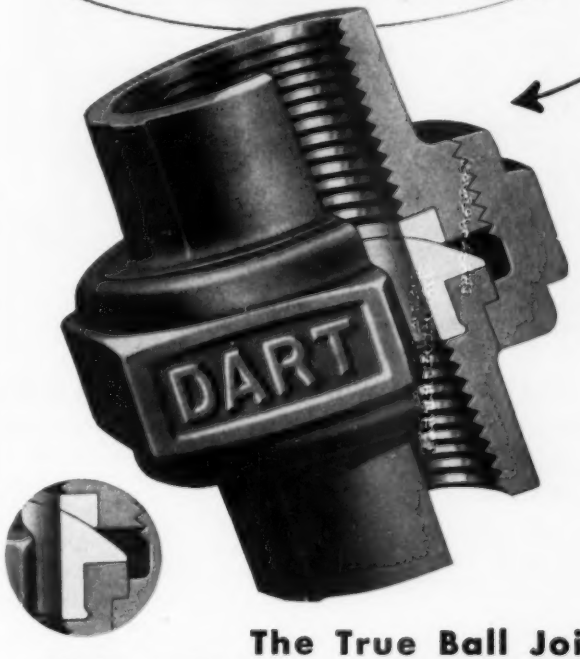

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HELPFUL BULLETINS

(Continued from page 36)

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MISCELLANEOUS

129 **Diesels, Their Fuels and Lubricants**—This 46-pp book offers a well organized and attractive presentation of practical information on Diesel engines, covering their history and economics as well as discussing their design characteristics and operating principles. Classification of Diesels according to speed is explained. Other chapters cover injection systems, combustion chambers, lubricating systems, and Diesel oil purification and filtration. The balance of the book is devoted to a discussion of fuel and lubricating oil required by Diesels and description of company's products. Book is filled with photos, sectional illustrations and schematic drawings and includes table showing relation of engine performance characteristics to fuel properties. Sinclair Refining Co.

130 **Coal Dust Control**—"For 1c a ton—complete freedom from coal dust, and for another 1¢, dustless ashes," is the story told in this 4-pp illustrated bulletin describing a system of dust control in coal and ash handling. Tells advantages and applications of system, explains equipment and "wet water" solution used. Aquadyne Corp.

131 **Selective Hardening**—This 6-pp folder gives detailed examples with photos of the application and use of a pack-hardening paste and isolating paste. Includes price schedule. Denfis Chemical Laboratories, Inc.

132 **Air Handling Progress**—Bulletin 4224 is Vol. 5 in company's collection of advertisements showing how air handling equipment serves public utilities and various industries. Contains some 40 pp and includes many photos of installations. American Blower Corp.

133 **Locomotive Crane**—Specifications and construction details covering a 25 t Diesel electric locomotive crane, in which deck operations are accomplished by Diesel power and travel is by electric motors mounted in each truck, are presented in Catalog 6000 L-8, 4 pp. Photos show crane at work, also underside and topside assembly. American Hoist and Derrick Co.

134 **Heat Exchangers**—Illustrated Catalog 1149, 8 pp, presents shell and tube heat exchangers of both single-pass and double-pass design, with removable tube bundles. Includes dimension tables and diagrams, instructions for figuring oil and water cooling capacities. Photos show several installations of these exchangers. Young Radiator Co.

CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

BOILERS AND AUXILIARIES

201 **Working Pressure Data Card**—Maximum allowable working pressures for water tube and fire tube boilers are compiled in a handy reference table, Technical Data Card No. 113 A. It lists pressures in pounds per square inch for seamless and electric resistance welded carbon steel tubes or nipples for different diameters and gages of tubes conforming to ASME specifications. Chart, covers 2 letter-size pages, is printed on firm stock, and punched for use in binder. The Babcock & Wilcox Tube Co.

202 **Dowtherm Vaporizer**—Bulletin No. 48-2, describing manufacturer's Type

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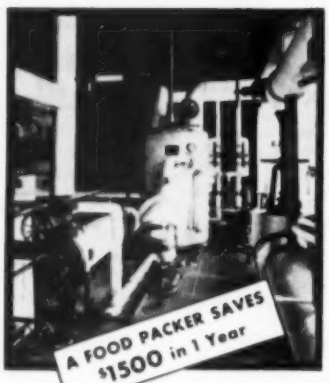

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203 **Water Tube Boilers**—This 12-pp bulletin illustrates and describes special and standard power plant boilers and packaged steam generators. Includes data and dimensions. Springfield Boiler Co.

VALVES, TRAPS, PIPING

204 **Pipe Distribution System Data** — "Engineering Distribution Data for Underground Steam Distribution," is the title of Section 450-2, 34 pp. of practical usefulness to those who deal with problems involved in insulated piping distribution systems. It covers layout of the route and methods of estimating steam loads, includes steam flow charts and tables, and gives properties of steel pipe, copper water tube piping and saturated steam. Also gives specifications of steam and hot water distribution piping with prefabricated pipe conduit. It's illustrated with photos of field installations and industrial applications of insulated pipe units, also sketches showing method of making field closures. The Ric-Wil Co.

205 **Piping Materials Catalog**—Corrosion resistant valves and piping materials are covered in illustrated circular No. 320, 32 pp. Contains information on manufacturer's complete line of valves, fittings, fabricated piping and pipe coils to meet a wide range of corrosive conditions. Listing includes both photos and cutaway drawings of models, complete specifications, sizes and prices. Includes a description of alloy metals used and a corrosion questionnaire. Also included are several pages of condensed recommendations on the selection of piping materials according to service requirements as well as a pictorial chart showing basic types of valves with names of their component parts. Crane Co.

206 **Steam Specialties**—Here is a collection of bulletins covering manufacturer's line of thermostatic steam traps, inverted bucket steam traps, float-thermostatic steam traps, radiator traps and valves, alternating receivers and lift traps, self-operated temperature regulators, air venting equipment, water blenders, strainers. All equipment is illustrated by photos, its operation and applications discussed, and its capacities, dimensions and prices listed. Sarco Co., Inc.

207 **Pipe Hanger Catalog** — Ninety-page Catalog 10-D is a valuable buyer's guide for adjustable pipe hangers and supports. Covers hangers for attachments to pipe and to structure, hanger assemblies, spring hangers, hanger rods, pipe supports and related equipment. Each type described and illustrated by photo and dimensional diagram and listed with dimensions and prices. Catalog also includes standard specifications, photos of installations and terms of sale. Indexed for quick reference; punched for filing in binder. Grinnell Co., Inc.

208 **Valves Bulletin**—A new catalog section 12-H describes all types of the company's cast steel pressure-seal bonnet valves. Information on choosing the best size valve for your service is given in one page of the booklet under the title, "Correlation of Valve Size and Pressure Drop." Design and construction advantages of the valves are given and tables of pressure and temperature ratings. Details of design including operating mechanism, body design, disk piston, and other features are explained. Dimensional details are given in tabular form accompanied by dimensioned line drawings. A standard materials specification table is presented. Edward Valves, Inc.

209 **Rubber Expansion Joints** — This 8 page bulletin AD 137 tells about the application, construction, styles, service and advantages of the company's line of rubber expansion joints. Other information given, includes "How To Order" and a table of dimensions which is accompanied by dimensioned line drawings. The bulletin is well illustrated. The Garlock Packing Company.

210 **Control Equipment**—General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Catalog illustrates and describes

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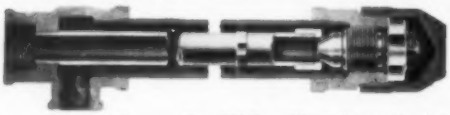

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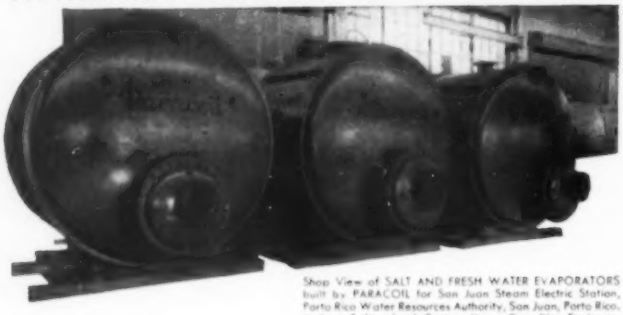

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in detail: venturi tubes and meters, controllers, gages, manometers, pitot equipment. Includes capacity tables, dimensional data, specifications, layout drawings. Simplex Valve and Meter Co.

211 Flanges for Severe Service—This 4-pp bulletin describes and illustrates a flange specially developed for services involving severe abrasion and corrosives, and for use in suction and discharge service. Photos and sketches illustrate the flange and its parts. Bulletin also covers a flexible rubber pipe for use with abrasive or corrosive material, as well as an acid- and corrosion-resistant duct, listing solutions this duct will handle. Goodall Rubber Co.

HEATERS, HEATING

212 Fan Heater Bulletin—Here's a 2-pp illustrated bulletin (No. 109) on a new high pressure steam fan heater designed for complete utilization of both sensible and latent heat of high pressure steam. One page is devoted to description and photos of the heater. Other page contains a sketch in color showing how the heater works. Niagara Blower Co.

213 Packaged Heat—Unit heaters featuring low first cost, easy installation and continued low cost per Btu are presented in this 12-pp booklet. Text explains how these packaged heaters are designed to operate instantly on oil or gas, fit heat output to requirements of day, and provide heat where it's wanted. Illustrations include photos of heaters and several installations and many sketches showing advantages and construction details. Frat-Daniel Corp.

214 Tubular Heat Exchangers—Bulletin 916, 32 pp, is highly informative. The bulletin describes the present designs of the company's tubular heaters, coolers, condensers and heat exchangers and their distinctive features. The various types of shells, tube bundles, stationary heads and floating heads are fully explained, together with statements of the particular services for which each is suitable. An additional helpful feature of the bulletin are tables of the characteristics of tubing, the thermal resistance of tubes and pipes of many different metals and alloys, and the specific gravity and pounds per gallon corresponding to degrees Baume and API. Also presented are charts of specific heats of midcontinent crude oils and for solving MTD formula with correction factors for other than countercurrent conditions. The Griscom-Russell Co.

215 Chemical Soot Removal—Ten-pp Bulletin 43, on the chemical removal of soot from boiler furnaces, explains the research work that led to the development of manufacturer's new chemical soot remover and slag alleviator for coal fired boiler furnaces. It tells how this combustion catalyst prevents soot formation on furnace internals and helps to end the smoke problem. National Aluminate Corp.

216 Water Heaters—Illustrated 6-pp Bulletin 70, Section I, on instantaneous type water heaters contains detailed capacity and dimension tables for two-pass, four-pass and six-pass designs, with tube bundles removable for inspection. A typical piping hook-up for installation of these heaters is shown. Also included are instructions for heater selection, engineering data to determine boiler capacities required for heating water, and a chart to determine pipe sizes for any steam flow at most pressures. Davis Engineering Corp.

217 Tubular Heater—A simplified vertical tubular heater suitable for every process duty and designed to hold initial and maintenance costs to a minimum, is the subject of 4-pp Bulletin 0-49-7. Includes a complete description of this simplified design which features the use of bare tubes and the absence of any metal parts exposed to furnace gases, also a discussion of the design's advantages. Cutaway drawings illustrate text. Foster Wheeler Corp.

218 Condensate Drainage Control—Manufacturer's system of high-pressure and high temperature condensate drainage control is fully explained in 24-pp Publication No. 3250. Contains useful data on steam flow conditions and heat exchange characteristics. Gives material and operating specifications and capacity ratings for both standard and high differential units in six sizes from 3 to 25 hp based on a maximum of 200 psi above process pressure. Differential pressures to 200 psi are listed and capac-

itles for each unit tabulated for unit inlet pressures. Illustrations include photographs and dimensional drawings in color showing design and construction of both types of units. Cochrane Corp.

TREATMENTS, PREVENTIVES

219 **Water Conditioning Bulletin**—This is an eight-page discussion of water and chemicals developed for conditioning it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition and application. Also discusses special purpose chemicals. Wright Chemical Corp.

220 **Corrosion Analysis**—Excellent working data on galvanic corrosion is contained in this 8-pp technical study of corrosion by concentration cells, reprinted from Inco Corrosion Reporter, Vol. 3, No. 1. Discusses concentration cells, the metal-ion cell type, oxygen cell type, reversible concentration cells, their practical aspects and some rules for minimizing or preventing concentration cell corrosion. Illustrated with sketches showing conditions which accelerate corrosion. The International Nickel Co., Inc.

221 **Corrosion Resistance of Nickel Alloys**—Technical Bulletin T-3 contains 44-pp of illustrated information on the resistance of high nickel alloys to corrosion by sulfuric acid. Although technical in nature, it is written so as to be readily understood by non-technical staffs. Performance of 30 nickel-bearing materials in a wide range of service is discussed, and there are 86 tables and 33 graphs and photos in addition to text. Problems involving a wide range of operations from the pickling of steel to petroleum refining and textile processing are covered. The International Nickel Co., Inc.

222 **Cleaning Industrial Equipment**—This is a general information bulletin on manufacturer's service for cleaning steam generating, heat exchange and other industrial equipment. Also included is information on pipe line cleaning and water well acidizing. Illustrations of these services are included, and bulletin treats in detail the methods used to remove incrustations from internal surfaces economically with minimum of downtime. Dowell Inc.

223 **Anti-Foam Treatment** — This 4-pp bulletin covers a new formula in powder form to be applied along with anti-scale treatment for improving steam quality, controlling scale in boiler feed system and sludge conditioning. It discusses the problem of steam contamination and explains the action of this polyamide anti-foam treatment. Tells how it should be applied and gives dosage requirements. A discussion of its advantages is accompanied by photos showing the effect of polyamide action on a boiling dilute Nacconol solution. Dearborn Chemical Co.

224 **Boiler Corrosion**—A 12 page article discussing the cause and prevention of corrosion in boiler systems is presented in Betz Technical Paper No. 111 titled "Corrosion: Its effect in Boiler Systems." The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity and physical factors are evaluated. Numerous illustrations, graphs and tables aid in understanding the article. W. H. & L. D. Betz.

225 **Turbine Blade Deposit Study**—Identification and prevention of steam turbine blade deposits and boiler water conditioning to prevent such deposits are discussed in the new 16-pp illustrated Bulletin 28B7030. Describes x-ray diffraction methods employed by the company for identification purposes and the results obtained. Tables list the partial chemical analyses of deposits containing sodium disilicate, occurence data on compounds found, composition of turbine deposits from turbines operating at various throttle pressures and temperatures, and comparison of compounds found in turbine blade deposits with boiler operating pressures. Allis-Chalmers Mfg. Co.

226 **Boiler Water Manual**—Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-page technical bulletin, called Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater systems. Also discusses condensate returns, flushing periods, condenser cooling water treatment and chemical tanks. Illustrations include photographs of two feeders and diagrams of the various methods described. Punched for filing in ring binder. Proportioneers, Inc.

227 **Water Softener Equipment** — How the problems caused by hard water can be offset by the use of water softeners is explained in Bulletin 2386, 12 pp, describing ion exchange equipment. It covers in detail downflow, upflow and gravity zeolite water softeners. Contains a 2-pp cutaway illustration of a fully automatic softener to show how an ion exchanger is built and how it works. Bulletin also contains flow diagrams showing arrangements for installation of water softeners and includes detailed, illustrated discussion of multiport valves used in them. The Permutit Co.

228 **Corrosion Treatment** — "Corrosion Protection of Steam and Condensate Return Systems" is a 4-pp folder covering a recently developed amine treatment for inhibiting of boiler and condensate systems. This treatment is described as affording surface protection of the metal itself as well as raising the pH value of the condensate. Booklet gives specific case histories and typical economies obtained by power plants using this treatment. Includes graphs showing relationship between free CO_2, pH and alkalinity in water, and the solubility of oxygen in water when exposed to air at various pressures The Bird-Archer Co

229 **Chemical Feed Systems** — Single, complete "packaged" units for feeding directly into boiler feed water lines are the subject of 4-pp Bulletin 4811. It discusses in detail sodium sulfite feeding, internal treatment, chemical feeding, manual control, intermittent feeding of internal treating chemicals; automatic feed systems; automatic pH control, and automatic control by conductivity. Illustrations include photos and diagrams of controlled volume pumps and a typical packaged installation. Milton Roy Co.

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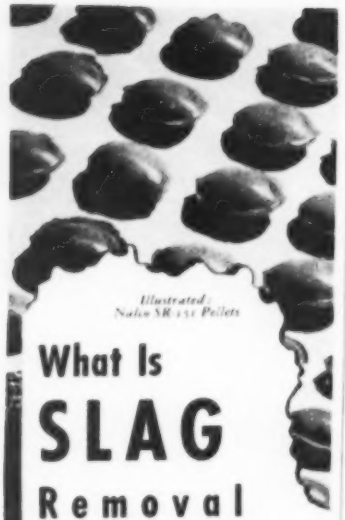

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ELECTRICAL

230 **Large D-C Motors**—Latest construction features of manufacturer's large d-c motors for applications requiring wide speed variation and fine speed control are described in 40-pp Bulletin OB56002A. Included is a comprehensive description of "frog leg" armature windings, a combination wave and lap winding that gives good commutation without cross-connectors and views of the new style mill-type spherical seated thrust bearing with welded-steel pedestal for heavy service. Controls for the motors, currently being used to drive metal rolling equipment, mine hoists, paper machines rubber mill rolls, plastic calendars and traction equipment are also covered. Allis-Chalmers Mfg. Co.

231 **Synchronous Generators**—This Bulletin, 05B6139A, describes construction features and electrical characteristics of engine-type synchronous generators in standard ratings from 25 to 10,000 kva and for standard speeds from 100 to 600 rpm, for Diesel, steam or gas engines. Also describes and illustrates mechanical construction of stators and rotors and discusses machine characteristics, ratings, voltages, frequencies, phases, temperature rises and operation at high elevation. Illustrations show typical installations. Available control accessories are listed, as are manufacturer's other products and territorial sales offices. Allis-Chalmers Manufacturing Co.

232 **Synchronous Motors — High speed** synchronous motors are described in this recently-issued 4-pp bulletin PB 5600-1. The bulletin is packed with descriptive matter and photographs explaining features of the motors rotor and stator. Mechanical modifications also are illustrated. Elliott Co.

PUMPS, COMPRESSORS, ENGINES

233 **Rotary Pumps**—Catalog LG, 4 pp, provides cutaway drawings and description of six different types of company's "IMO" rotary pumps, designed to handle residual and distillate fuel oils, crude oils, lubricating oils, viscous fluids and similar liquids. Discusses reliability, high speeds freedom from pulsation, accessibility and other advantages of these pumps in capacities ranging from 0.5 to 1000 gpm for pressures to 500 psi, and to 150 gpm for pressures to 1500 psi. DeLaval Steam Turbine Co.

234 **Steam Engine Governor Data**—This new bulletin No. 502, describes the company's Type EN fully enclosed self-lubricated governor which is described as giving "precise, dependable engine speed control." Illustrations of the unit are presented and a parts list, accompanied by a sectional diagram is given. One section "Installation and Care" tells how to assemble governor to engine cylinder and how pulleys should be proportioned, the proper type of belt for use with the governor, correct lubrication procedure, method of packing and other data. Troy Engine & Machine Co.

235 **Condensers**—Bulletin 441-C, 28-pp, covers in detail every phase of manufacturer's line of condensers—their simplicity of design, accessibility, construction features. Illustrated with photos and drawings showing complete assemblies, parts, principles of operation. Bulletin also discusses emergency replacements, service and maintenance facilities available, and auxiliary equipment. Includes condenser tube data, pressure-conversion tables. Condenser Service & Engineering Co.

236 **Compressor Selection Chart**—Here's a new selection chart, based on normal applications handling air with atmospheric intake pressure. It simplifies selection of proper size compressor for average industrial use, with quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute and shows recommended compressor bore and stroke in inches. Chart covers two letter-size pages. Worthington Pump and Machinery Corp.

237 **Air Compressor Lubrication Manual**—Valuable information on air compressor maintenance is contained in this 40-page book on the lubrication of air compressors, second edition. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements operating hints, oil requirements, storage and care of compressor oils, and safety precautions. All discussions are illustrated with large clear photographs and drawings showing construction and operation of compressors, their lubricating systems, etc. Cities Serv-

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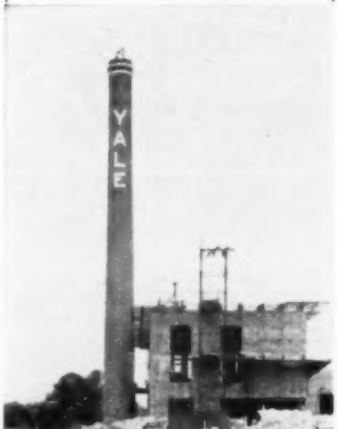

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238 **Steam Pumps** — This is manufacturer's collection of bulletins covering all types of centrifugal and reciprocating pumps for a wide range of industrial uses. Contains more than 80 pp in all and includes photos, dimensions, specifications, ratings and application data. Warren Steam Pump Co.

INSTRUMENTS AND CONTROLS

239 **Smoke Density Recorder** — Bulletin 211, 4 pp, tells how company's bolometer-type smoke density recorder promotes efficient furnace operation and how it helps in the battle against smoke nuisance. It describes and illustrates the smoke detector which consists of a bolometer receiving and measuring radiation from a sealed beam light source. Recorder specifications, installation requirements, and measuring circuit details are also discussed. Bailey Meter Co.

240 **Boiler Water Level Control** — Bulletin 487 describes completely the installation of boiler water level control equipment at the Blackhawk Generating Station, Wisconsin Power & Light Company. Photographs of the installation are presented as is a schematic layout of the entire station along with tabulated significant data. A large, full-page cross section of the B & W Type FH integral furnace boiler is presented and other drawings and photographs show the accompanying equipment. Northern Equipment Company.

241 **Water Gages** — Eight-page Bulletin E-1 covers line of water gages for stationary and locomotive boilers, marine and refinery service and tanks for all pressures and temperatures. Listings include photos of all gages, sizes and construction details. Bulletin S-2, four pages, covers gage glasses, glass guards, sight flow indicators and related equipment. Ernst Water Column & Gage Co.

242 **Instrument Handbook** — "Modern pH and Chlorine Control" is a 100-pp catalog containing a great deal of valuable information in addition to covering manufacturer's line of scientific instruments and accessories. It explains the meaning of pH control, the electrometric and colorimetric methods of determining pH, and gives values of common acids, bases and foods, as well as maximum capacities of buffer systems. It also discusses in detail the applications of pH and chlorine control in air conditioning, water treatment, boiler water and many other industrial applications, recommending instruments and solutions. Instruments are illustrated by photograph, their functions described and prices given. W. A. Taylor & Co.

243 **Temperature Measuring Instruments** —For all those responsible for the safe operation of electric power equipment, this company has just issued a revised 34 page catalog ND4-33-46I describing the company's instruments for measuring the temperature of generators, motors, condensers, transformers, etc. The bulletin covers a wide variety of instruments, portable and automatic indicators, for checking in any order on temperatures. Reference also is made of new and specialized instruments for measuring in rapid succession a number of bearing temperatures. Leeds & Northrup Co.

244 **Recording Instrument Data Book** — An oxygen-analyzer, based on the para-magnetic property of oxygen, is described and illustrated in Bulletin 49-829, 16 pp. Tells advantages and applications of the instrument; also discusses manufacturer's analyzer for carbon dioxide and other gases and an electronic recorder (temperature and pressure) for use with analyzers. Describes several recommended gas sampling systems. The Hays Corp.

245 **Metering Chlorine** — Bulletin 640-P2 describes an instrument designed to accurately meter chlorine gas and deliver a chlorine water solution to the point of application. Discusses the safety and other features of the instrument and explains its operation and maintenance. Illustrations include photos, a phantom drawing showing principle working parts, and a layout diagram. Builders-Providence, Inc.

246 **Purity Indicator** — An instrument for measuring and indicating electrical conductance of steam and water is described and illustrated in 6-pp Bulletin 11-23-48 RCD. It discusses problems encountered with steam and condensate purity and cites examples of how controller and alarm assembly are utilized in detecting and signalling impurities caused by carry-over and condenser leakage. Includes photos of typical test apparatus, also prices. E. F. Drew & Co., Inc.

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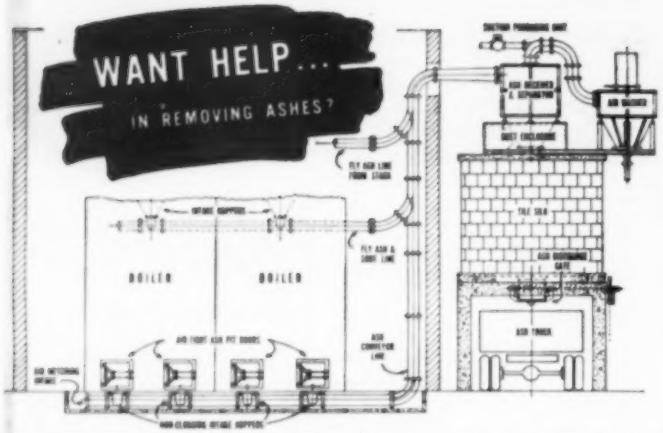

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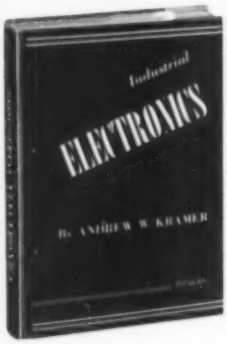

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247 **Screw Conveyor**—Two-pp Form A-84 describes a high-speed, direct-feed, bin-to-stoker screw conveyor that comes ready to set up. Illustrations show this conveyor in use and detail of its principal parts. Stresses economy of this conveyor in handling coal and includes specifications. Baughman Mfg. Co., Inc.

248 **Coal Scale Data Book**—The answers to a power engineer's questions on coal scales are provided in this excellent 48-pp book, Bulletin 1143, covering scales for recording weight of coal consumed by individual boilers and weight of coal receipts from ship, car, truck or storage. It is generously illustrated with photographs of models and accessories and actual plant installations and contains all necessary engineering drawings, dimensional data and detailed specifications. Construction features and operation of weighing and feeding systems are described. Richardson Scale Co.

249 **Spreader Stoker Selection** — Fourteen-pp Form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered in the selection. It pictures and describes in detail the principle operating parts of manufacturer's stokers, emphasizing their advantages. Includes engineering drawings and photos of typical installations. American Engineering Co.

250 **Coal Crushing, Sizing** — Bulletin 3007 describes the company's Bradford breaker a coal crusher, sizer and scavenger. The bulletin presents drawings of the breaker, tells how it works and then presents the complete story of its operation at the coal mine and coal cleaning plant at the By-Product Coke Plant and at the Power Station. The back section of the catalog presents engineering information on capacities, dimensions and dimensioned line drawings. Pennsylvania Crusher Co.

251 **Coal Crusher**—In this 8-pp bulletin a rolling ring crusher is presented as a solution to the problem of uniform stoker coal. Describes the special features of this crusher, emphasizing its shredder

(Continued on page 132)

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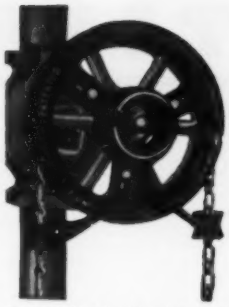

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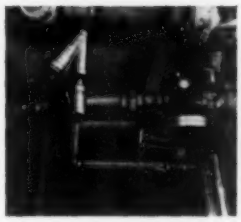

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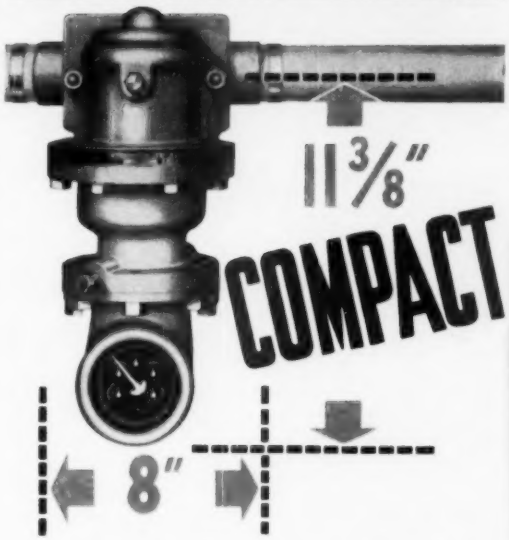

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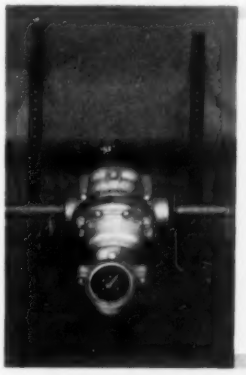

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CATALOG LIBRARY

(Continued from page 128)

designed to split coal rather than crush it. Gives speed, capacity, weight and dimensions of available models and illustrates principle of operation. Also contains photos of parts and several complete installations. American Pulverizer Co.

252 Underfeed Stokers—Bulletin 350, 24 pp. features a single retort underfeed stoker which may be operated by electric or steam drive. It is described as a complete firing unit for burning various grades of bituminous coal with high efficiency for boilers from 50 to 150 hp rated capacities. Generously illustrated, the bulletin explains the operation of these stokers, tells their applications and economy and gives sizes and capacities. Also contains installation photos and diagrams. Detroit Stoker Co.

TURBINES

253 Turbine Catalog Collection—This is a valuable collection of bulletins in loose-leaf form. They cover a complete description of manufacturer's solid wheel turbines and feature cross section drawings of typical units for both moderate and high steam pressure conditions. Also provides a description of an axial flow impulse, both single and multi-stage, and complete data on speed increasing and speed reduction gears. The Terry Steam Turbine Co.

254 Velocity Stage Turbines — Catalog 82-198R, 8 pp, features turbines for mechanical drives designed to operate under all inlet steam conditions up to 600 psig and 750 F. Gives complete specifications, dimensions and includes chart showing how to estimate turbine sizes. Illustrations include cutaway view, photos of parts. Speed governor and regulating valve, and emergency governor and trip valve are described in detail. De Laval Steam Turbine Co.

255 The Answers on Turbine Oil—This 2-pp booklet answers several questions power engineers ask about turbine oils, including: What causes deposits of sludge? What causes acidity increase? What causes corrosion in turbines? Explanations are brief but thorough. Booklet is illustrated with photos of turbine installations in which manufacturer's products have been used successfully. Standard Oil Co. (Indiana).

MISCELLANEOUS

256 Pump Packings—Packings for use on reciprocating and centrifugal pumps are illustrated by photo and described in this 4-pp folder. It covers packings for practically all services and includes a table of recommendations to facilitate selecting the right packing for any particular application. Johns-Manville.

257 Concrete Floors Q & A — A new booklet titled Lumnite Concrete Floors—Corrosion Resistant and Heat Resistant, has just been published. The detailed information contained in this booklet brings up to date, the service experiences and late developments in this field. The information covers methods and materials used in placing corrosion resistant concrete in a wide variety of industrial applications. Typical uses of corrosion resistant concrete are listed for many industries and also given, are the answers to a number of questions often asked about it. A section on placing and finishing corrosion resistant floors will be helpful to prospective users. Lumnite Division, Universal Atlas Cement Company.

258 Tube-Ice Machine — Bulletin TI-3 describes manufacturer's automatic ice-making machine for producing either cylinder or crushed ice. Explains and illustrates machine's operation, discussing its small space requirement, quick freezing time, reduced power consumption and economy. Its application in the dairy and packing industries, breweries, chemical plants, institutions, and ice plants are described and pictured. Also discussed is the utilization of this machine in cold water refrigeration for air conditioning systems. Includes chapter on the handling and storage of ice. Henry Vogt Machine Co.

259 Purger Bulletin—How air and other non-condensables get into refrigeration systems; the adverse effect of this on operating costs and efficiency and what manufacturer's forged steel purger does to prevent it are covered in 8-pp Bulletin 192. Also included are installation data with illustrations and diagrams, specifications and prices, helpful charts and tables. Armstrong Machine Works.

260 Water Hardness Test—This technical bulletin presents a test procedure for determining hardness of water, by use of a color indicator which is described as both easy and accurate. Instructions for running the test are illustrated in color. Includes prices of company's complete hardness titration set and individual solutions used. W. H. & L. D. Betz.

261 Dust Collectors — Dust collecting equipment for power plants, foundries, cement plants and similar industries is the subject of Bulletin No. 1428, 26 pp. Contains many photographs of installations, also photos showing equipment being tested in company laboratories. Discusses services offered by manufacturer in analyzing individual installation requirements and recommending equipment for the job. American Blower Corp.

262 Reference Bibliography for Water, Sewage and Power Plant Engineering—This 36 page, paper bound bulletin consists of a comprehensive and up-to-date listing of the best available sources of information on use of water for drinking and also for boiler feedwater supply; on sewage treatment and industrial waste treatment; and on power plant design and operation. The bibliography lists first a number of books and magazines covering water supply, treatment, treatment plant design and operation. Next, publications on the bacteriology of water and sewage. Third, publications covering sewage and industrial waste treatment and chemistry and analysis of water and sewage. Fourth, publications on power station design, operation and equipment and finally standard engineering handbooks, data and aid for hydraulic and power engineering. A list of foreign publications is also given. Also a list of periodicals on chemical laboratory procedure, water and sewage, and a good list of manufacturers publications. Published by Gilbert Associates, Inc.

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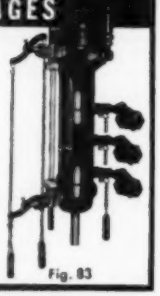

Fig. 83

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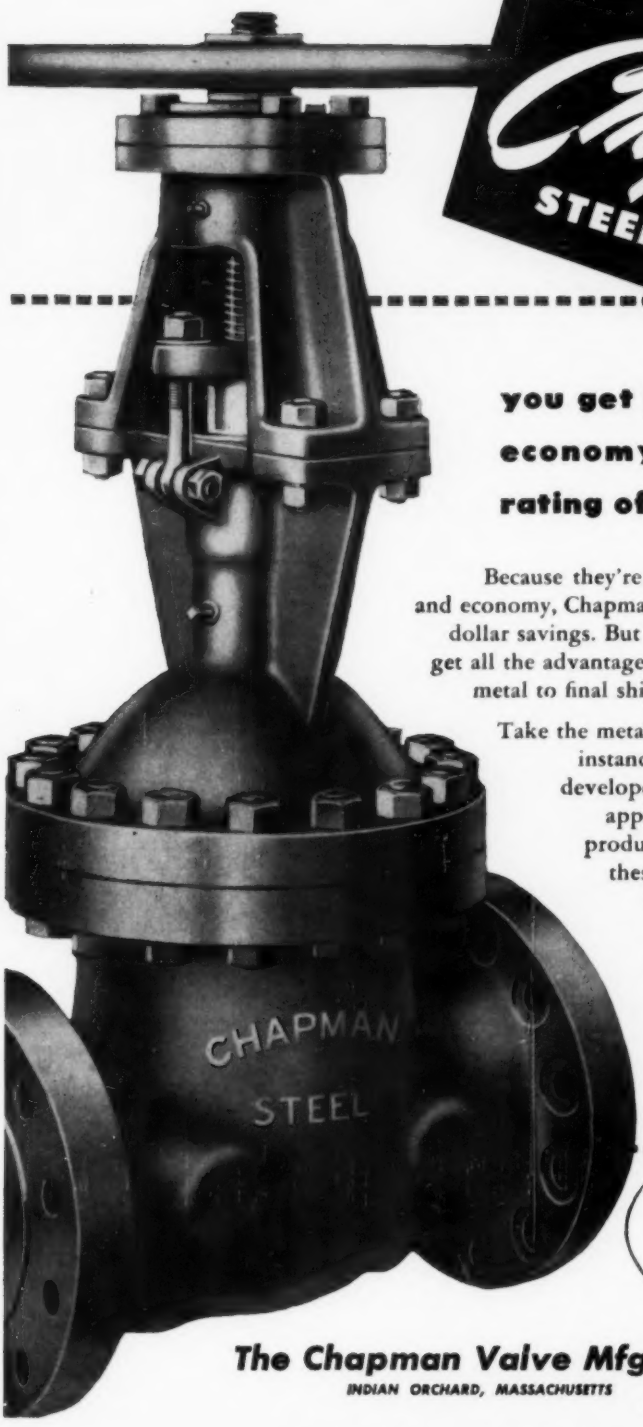

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CHARACTERISTICS
Conventional Design
Sludge Blanket Design
Silica in raw water, as SiO2ppm 55 55
Silica in effluent, as SiO2ppm 11 2.0
MgO feed, ppm 76 59
Parts SiO2 removed per part MgO 0.6 1.1
Average retention time of Mg(OH)2 in hours 4.7 100
Contact time of water with Mg(OH)2 in minutes 92 87
Hardness of effluent, as CaCO3ppm 21 15
Average load on softener, % rated capacity 65 46
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